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A monthly publication of the Geological Survey
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The Secretary of the Interior has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Office of Management and Budget through September 1989.

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. administration.

PREFACE

Selected Water Resources Abstracts, a monthly journal, includes abstracts of current and earlier pertinent monographs, journal articles, reports, and other publication formats. These documents cover water resources as treated in the life, physical, and social sciences and the related engineering and legal aspects of the characteristics, supply condition, conservation, control, use, or management of water resources. Each abstract includes a full bibliographic citation and a set of descriptors which are listed in the **Water Resources Thesaurus.** The abstract entries are classified into 10 fields and 60 groups similar to the water resources research categories established by the Committee on Water Resources Research of the then Federal Council for Science and Technology.

Selected Water Resources Abstracts is designed to serve the scientific and technical information needs of scientists, engineers, and managers as one of several services of the Water Resources Scientific Information Center. The cumulative SWRA file from 1968 and monthly updates are available also in magnetic tape through lease from NTIS.

THE WATER RESOURCES SCIENTIFIC INFORMATION CENTER DOES NOT PROVIDE COPIES OF DOCUMENTS ABSTRACTED IN THIS JOURNAL. Sufficient bibliographic information is given to enable readers to order the desired documents from local libraries or other sources.

Comments and suggestions concerning the contents and arrangement of this bulletin are welcome.

Water Resources Scientific
Information Center
U.S. Geological Survey
MS 425 National Center
Reston, VA 22092

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01 NATURE OF WATER

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Includes the following Groups: General; Precipitation; Snow, Ice, and Frost; Evaporation and Transpiration; Streamflow and Runoff; Groundwater; Water in Soils; Lakes; Water in Plants; Erosion and Sedimentation; Chemical Processes; Estuaries.

03 WATER SUPPLY AUGMENTATION AND CONSERVATION

Includes the following Groups: Saline Water Conversion; Water Yield Improvement; Use of Water of Impaired Quality; Conservation in Domestic and Municipal Use; Conservation in Industry; Conservation in Agriculture.

04 WATER QUANTITY MANAGEMENT AND CONTROL

Includes the following Groups: Control of Water on the Surface; Groundwater Management; Effects on Water of Man's Nonwater Activities; Watershed Protection.

05 WATER QUALITY MANAGEMENT AND PROTECTION

Includes the following Groups: Identification of Pollutants; Sources of Pollution; Effects of Pollution; Waste Treatment Processes; Ultimate Disposal of Wastes; Water Treatment and Quality Alteration; Water Quality Control.

06 WATER RESOURCES PLANNING

Includes the following Groups: Techniques of Planning; Evaluation Process; Cost Allocation, Cost Sharing, Pricing/Repayment; Water Demand; Water Law and Institutions; Nonstructural Alternatives; Ecologic Impact of Water Development.

07 RESOURCES DATA

Includes the following Groups: Network Design; Data Acquisition; Evaluation, Processing and Publication.

08 ENGINEERING WORKS

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09 MANPOWER, GRANTS, AND FACILITIES

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SELECTED WATER RESOURCES ABSTRACTS

2. WATER CYCLE

2A. General

HYDROLOGY OF THE MANOKIN, OCEAN CITY, AND POCOMOKE AQUIFERS OF SOUTHEASTERN DELAWARE,
Delaware Geological Survey, Newark.
For primary bibliographic entry see Field 2F.
W89-04619

USING EXOGENOUS VARIABLES IN TESTING FOR MONOTONIC TRENDS IN HYDROLOGIC TIME SERIES,
Geological Survey, Reston, VA.
W. M. Alley.
Water Resources Research WRERAO, Vol. 24, No. 11, p 1955-1961, November 1988. 5 tab, 18 ref.

Descriptors: *Model studies, *Mathematical models, *Statistics, *Hydrologic Cycle, *Time series analysis, Monte Carlo method, Regression analysis.

One approach that has been used in performing a nonparametric test for monotonic trend in a hydrologic time series consists of a two-stage analysis. First, a regression equation is estimated for the variable being tested as a function of an exogenous variable. A nonparametric trend test such as the Kendall test is then performed on the residuals from the equation. By analogy to stagewise regression and through Monte Carlo experiments, it was demonstrated that this approach will tend to underestimate the magnitude of the trend and to result in some loss in power as a result of ignoring the interaction between the exogenous variable and time. An alternative approach, referred to as the adjusted variable Kendall test, is demonstrated to generally have increased statistical power and to provide more reliable estimates of the trend slope. The utility of including an exogenous variable in a trend test was examined under selected conditions. In this regard, when testing for the effects of human activities on streamflow, consideration should be given to obtaining an exogenous variable as the output from a hydrological model with model parameters based on natural conditions. Good practice is to apply and report the results of several trend detection approaches, e.g. using several different exogenous variables. (Sand-PTT)
W89-05065

ION MASS BUDGETS FOR LAKES IN THE TURKEY LAKES WATERSHED, JUNE 1981-MAY 1983,
National Water Research Inst., Burlington (Ontario).
For primary bibliographic entry see Field 5B.
W89-05086

APPLICATION OF A HYDROLOGICAL MODEL TO THE ACIDIFIED TURKEY LAKES WATERSHED,
National Water Research Inst., Burlington (Ontario). Rivers Research Branch.
For primary bibliographic entry see Field 5B.
W89-05090

WATER AND CHEMICAL BUDGETS FOR TERRESTRIAL BASINS AT THE TURKEY LAKES WATERSHED,
Great Lakes Forestry Research Centre, Sault Sainte Marie (Ontario).
J. A. Nicolson.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 45, Suppl. 1, p 88-95, 1988. 1 fig, 3 tab, 28 ref.

Descriptors: *Water pollution sources, *Canada, *Ecosystems, *Ion transport, *Acid rain effects, *Hydrologic budget, Alkalinity, Elevation, Conductivity, Sampling, Precipitation, Deposition, Chemical properties, Lake basins, Ontario, Sulfates, Chlorides, Nitrates.

Twenty terrestrial basins ranging in area from 2.3 to 62.7 hectares were monitored in the 1050-hectare Turkey Lakes Watershed (TLW) to measure discharge and ion loss from the terrestrial ecosystem and to estimate terrestrial contributions to the main aquatic system. These basins span 400 meters of elevation, beginning at 60 meters above Lake Superior (183 meters above sea level. Annual streamflow represented 28-63% of precipitation; 30-60% of the total occurred during springmelt. Water, H(+), and NH4(+) output of the small basins increased with basin elevation; conductivity, alkalinity, Ca(++), and NO3(-) decreased. Losses of Mg(++), K(+), Na(+), SO4(--), and Cl(-) were not related to basin elevation. Input-output values indicate a net loss of Ca(++), Mg(++), K(+), and Na(++); Cl(-) slowly accumulated, N was strongly retained, and SO4(--) was generally in balance. Alkalinity values indicate that HCO3(-) was important in balancing cation losses in low-elevation basins but that SO4(--) dominated in high-elevation basins. Output of H(+) was substantially lower than its input through precipitation at all elevations; however, H(+) removal by the terrestrial system was greater in low-elevation than in high-elevation basins within the main watershed. Precipitation quantity and SO4(--) and NO3(-) input were measured at the Atmospheric Environment Service APN station southeast of the TLW; other chemical parameters were measured on samples collected near the main outlet on the west side of the TLW. (See W89-05082 thru W89-05092 thru W89-05092 thru W89-05101) (Authors abstract)
W89-05091

EVALUATION AND IMPROVEMENT OF HYDROLOGICAL CONCEPTS USED IN PAWN,
Rijksinstituut voor Zuivering van Afvalwater, Lelystad (Netherlands).
For primary bibliographic entry see Field 6B.
W89-05128

COMPUTER SIMULATION IN PHYSICAL GEOGRAPHY,
For primary bibliographic entry see Field 7C.
W89-05428

SELECTED PAPERS IN THE HYDROLOGIC SCIENCES 1986.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Supply Paper 2290. 1986. 154p. Edited by S. Subitzky.

Descriptors: *Geohydrology, *Water quality, *Hydrology, *Runoff, *Groundwater, *Rivers, *Lakes, *Reservoirs, *United States, Federal jurisdiction, Flow velocity, Surface-groundwater relations, Flow discharge, Limnology.

Results are presented of hydrologic studies derived from the Federal research program and the Federal-State cooperative program of the U.S. Geological Survey and some work supported by other Federal agencies. Papers cover the following: limnology of West Point Reservoir (Georgia and Alabama); geochemistry of Bradys Hot Springs (Nevada); possible formation of diethylnitrosamine from the use of rhodamine WT dye as a tracer; stream-aquifer interactions in coal areas of eastern Kansas; organic contaminants from wood-treatment processes in an aquifer near Pensacola, Florida; groundwater plume stabilization and removal strategies; growth and runoff from Gulkana Glacier (Alaska Range); flow simulation in meandering channels with flood plains; stream-discharge record reconstruction techniques; channel widening and bank slope development along Cane Creek (Tennessee); extraction of soluble amorphous phases from clays; velocity interpolation methods for computing open-channel discharge; and discharge computation from a small number of velocity observations. (See W89-05587 thru W89-05599) (Rochester-PTT)
W89-05586

DETERMINISTIC NATURE OF FLOOD FREQUENCIES: SOME OBSERVATIONS,
Calgary Univ. (Alberta). Dept. of Civil Engineering.
I. Muzik.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 37-47, 4 fig, 1 tab, 14 ref, 1 append.

Descriptors: *Rainfall-runoff relationships, *Flood frequency, *Rainfall distribution, *Statistical analysis, Fluvial systems, Hydrographs, Mathematical models, Watersheds.

The deterministic role that physical characteristics of watersheds have in the transformation process of probabilistic rainfall inputs into probabilistic peak runoffs is discussed. Analytical solution of kinematic wave flow over a single runoff plane and experimental hydrographs from a laboratory catchment were the methods of investigation. The dispersion and skewness of peak runoff series increase with increasing resistance to surface runoff and with decreasing bifurcation ratio, the mean basin slope, and the duration of rainfall. The results indicate that when the rainfall intensity distribution is of the two parameter type, such as normal or gamma distribution, with a rigid relationship between its coefficients of skewness and variation, the peak runoff distribution does not retain that rigidity. (See also W89-05642) (Author's abstract)
W89-05645

COMPARISON OF FLOOD-FREQUENCY ESTIMATES BASED ON OBSERVED AND MODEL-GENERATED PEAK FLOWS,
Geological Survey, Reston, VA. Water Resources Div.
For primary bibliographic entry see Field 2E.
W89-05651

PROBABILISTIC CHARACTERISTICS OF POINT AND AREAL RAINFALL,
Nagoya Univ. (Japan). Dept. of Civil Engineering.
U. M. F. Takagi.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analsyes, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 265-275, 12 fig, 5 ref.

Descriptors: *Statistics, *Meteorological data, *Probabilistic process, *Rainfall intensity, *Regional analysis, Simulated rainfall, Point rainfall, Areal rainfall, Peak rainfall, Flood frequency.

The time and spatial concentration of heavy rainfall results in the differences between point and areal averaging rainfall. The rainfall which is required for the flood control design in a drainage system is discussed in its areal properties. If the probabilistic relationships between point and areal rainfall are clearly established, probabilistic characteristics of areal rainfall can be estimated from the probability density function of point rainfall at a key gauging station. The simulation technique of the rainfall event over a certain region has been used to establish the probabilistic characteristics of point and areal rainfalls. The shift of the probability density function of point rainfall towards a lower rainfall intensity may give a good approximation to that of areal rainfall. Logarithmic-normal distribution provides a good approximation to the distribution of peak rainfall in a space. The rainfall intensity decreases linearly with the distance from the location of peak rainfall. Rainfall events have been simulated over a certain region, and the results introduce the relationship between statistical characteristics of point rainfall and areal average rainfall. If point rainfall itself is used for an over all drainage system, the design rainfall can be generally over-estimated compared to that obtained based on areal rainfall. (See also W89-05642) (Author's abstract)
W89-05660

COMPARISON OF THREE METHODS OF ESTIMATING RAINFALL FREQUENCY PARAMETERS ACCORDING TO THE DURATION OF ACCUMULATION,

University of Southern Mississippi, Long Beach.
M. Slimani, and T. Lebel.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 277-291, 7 fig, 2 tab, 18 ref.

Descriptors: *Meteorological data, *Duration analysis, *Hydrometeorology, *Rainfall intensity, Mathematical studies, Flood forecasting, Gumbel distribution, Least squares method, Mediterranean.

The Gradex method estimates high return period discharges by assuming that the two marginal increases in rainfall and flood volumes are equal for return periods greater than a hundred years. Three gradex estimators are compared from bias and efficiency standpoints: the moment and maximum likelihood methods used to fit a Gumbel distribution to an extreme value data set, and the moment method used to fit a two component exponential distribution to the complete data set of observed rainfalls. The fitting of a two component exponential model to all consecutive rainfalls uses the most hydrometeorological information and appears to be the best as long as the necessary data is available. The method is especially suitable when corresponding extreme value series cannot be well fitted by a Gumbel distribution. In cases where only extreme value series can be used, it was observed that maximum likelihood estimates could not compete with less sophisticated but more efficient moment fitting or least square fitting estimates. When a break or curve occurs in the point swarm, the least squares fit accounts for this break, and the upper part of the empirical distribution corresponds to a Gumbel distribution. If this part contains enough values, this method yields gradex estimates close to those of the two component exponential model. However, the robustness of the least squares estimate is poor when there are several high value outliers. The main advantage of working on parent distribution series rather than on extreme value series is the minimization of the influence of these high value outliers, observed in rainfall in the Mediterranean area. (See also W89-05642) (Author's abstract)
W89-05661

FREQUENCY ANALYSIS OF AUSTRALIAN RAINFALL DATA AS USED FOR FLOOD ANALYSIS AND DESIGN,
Bureau of Meteorology, Melbourne (Australia). Hydrology Branch.
For primary bibliographic entry see Field 2B.
W89-05662

STOCHASTIC FORMULATION OF STORM PATTERN AND RAINFALL INTENSITY-DURATION CURVE FOR DESIGN FLOOD,
Tokushima Univ. (Japan). Dept. of Construction Engineering.
For primary bibliographic entry see Field 2B.
W89-05663

SOME NEW PERSPECTIVES ON MAXIMUM ENTROPY TECHNIQUES IN WATER RESOURCES RESEARCH,
Naval Research Lab., Washington, DC.
For primary bibliographic entry see Field 7C.
W89-05667

ENTROPY PRINCIPLE IN THE ESTIMATION OF GUMBEL PARAMETERS,
Delhi Coll. of Engineering (India). Dept. of Civil Engineering.
For primary bibliographic entry see Field 7C.
W89-05672

ANOTHER LOOK AT THE JOINT PROBABILITY OF RAINFALL AND RUNOFF,
Oklahoma State Univ., Stillwater. Dept. of Agricultural Engineering.
C. T. Haan, and B. N. Wilson.
IN: Hydrologic Frequency Modeling: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 555-569, 2 fig, 5 tab, 12 ref, append.

Descriptors: *Design flood, *Rainfall frequency, *Statistical analysis, *Runoff forecasting, *Rainfall-runoff relationships, *Flood frequency, Probability distribution, Mathematical studies, Soil water.

Considerable discussion exists in the literature dealing with the relationship between the return period of a runoff event and the return period of the rainfall that produced the runoff. The assumption is usually made that the two return periods are the same when a design flow is estimated. This assumption has been widely criticized but continues to be used because of the lack of a suitable alternative. Differences in the return period of runoff and rainfall can be attributed to variation in the antecedent conditions that exist on a catchment at the time of a storm. A procedure that can simultaneously account for rainfall probability and antecedent condition probability is needed. A procedure for estimating the magnitude of a flow event for a given return period that incorporates the joint probability of rainfall depths and antecedent soil water conditions was developed. Rainfall probabilities were determined from the Extreme Value distribution, and soil water probabilities were based on 22 years of data from an experimental watershed near Stillwater, OK. The resulting flow estimates for a given return period were compared with similar estimates based on the assumption of equality of return periods for rainfall and runoff. As a result of allowing the possibility of large rains and wet antecedent conditions, it is possible for estimated flows for large return periods to be greater than similar estimates that treat the antecedent conditions as a constant and use return period rainfall directly. These procedures require greater study before any conclusions can be made. (See also W89-05642) (Davis-PTT)
W89-05681

FIELD APPLICATION OF PARAMETER IDENTIFICATION IN GROUNDWATER CONTAMINANT TRANSPORT MODELING: A CASE STUDY,
Washington Univ., Seattle. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W89-05781

MODELING TRANSIENT GROUND WATER FLOW IN MULTILAYERED AQUIFER SYSTEMS,
Georgia Inst. of Tech., Atlanta. School of Civil Engineering.
For primary bibliographic entry see Field 2F.
W89-05790

2B. Precipitation

COMPARISON BETWEEN BULK AND WET PRECIPITATION IN THE LUQUILLO RAIN FOREST,
Center for Energy and Environment Research, San Juan, PR.
For primary bibliographic entry see Field 2K.
W89-04671

ACIDITY OF RAIN IN PUERTO RICO,
Puerto Rico Univ., Mayaguez.
E. D. Osborne.
IN: Third Caribbean Islands Water Resources Congress. Proceedings of a Symposium held in St. Thomas, U.S. Virgin Islands, July 22-25, 1986. p 61-64, 2 fig, 1 tab, 3 ref.

Descriptors: *Water pollution sources, *Acid rain, *Puerto Rico, *Pollutant identification, Sulfates, Chemical analysis, Seasonal variation, Wind, Nitrates, Chlorides.

Acid rain is a phenomenon present in the environment of the island of Puerto Rico. There appears to be a seasonal trend with higher acidity manifested during the dry season of January to April. The best predictor of rain acidity in the group of ions (N03(-), S04(2-), and Cl(-)) analyzed is the SO4(2-). Wind patterns play a very important role in the geographical distribution of pollutants that cause the acidity of rain in Puerto Rico. (See also W89-04665) (Lantz-PTT)
W89-04675

RELATIONSHIP BETWEEN RAINFALL AND PEAT WATER CHEMISTRY AND THE IMPLICATIONS FOR MANAGEMENT AT CHARTLEY MOSS NATIONAL NATURE RESERVE, ENGLAND,
Nottingham Univ. (England). Dept. of Botany.
For primary bibliographic entry see Field 2H.
W89-04700

ACID DEPOSITION IN MARYLAND: THE STATUS OF KNOWLEDGE IN 1987.
For primary bibliographic entry see Field 5C.
W89-04861

ATMOSPHERIC TRANSPORT, TRANSFORMATION, AND DEPOSITION,
For primary bibliographic entry see Field 5B.
W89-04863

SOME MODELS FOR RAIN AND CLOUDS ATTENUATION OF MILLIMETER WAVES,
National Telecommunications and Information Administration, Boulder, CO. Inst. for Telecommunication Sciences.
For primary bibliographic entry see Field 7B.
W89-04882

AMBIENT CONCENTRATION AND PRECIPITATION SCAVENGING OF ATMOSPHERIC ORGANIC POLLUTANTS,
Texas A and M Univ., College Station. Dept. of Oceanography.
E. Atlas, and C. S. Giam.
Water, Air, and Soil Pollution WAPLAC, Vol. 38, No. 1-2, p 19-36, March 1988. 3 fig, 9 tab, 40 ref. NSF Grants OCE-81-11481 and 84-15726.

Descriptors: *Precipitation scavenging, *Path of pollutants, *Air pollution, *Organic compounds, Air-water interfaces, Chlorinated hydrocarbons, Texas, Precipitation, DDT, Polychlorinated Biphenyls, Rainfall, Trace levels.

Trace organic compounds were measured in air and rainfall at a rural site in Texas. Chlorinated hydrocarbons and phthalic acid esters were present at concentrations of ng per cu m in air and ng per l in precipitation. The most abundant compounds measured in air were phthalic acid esters > toxaphene > chlordane > hexachlorocyclohexanes (HCHs) > others. In rainfall, the concentration order was phthalic acid esters > toxaphene > HCHs > DDTs > chlordane > polychlorinated biphenyls > others. An inverse correlation between concentration and rainfall amount was observed for most compounds. A model of precipitation scavenging of these compounds considered both scavenging of gas-phase and particulate-bound compounds from the atmosphere. Good agreement was obtained between theoretical and measured concentrations. Results indicate that scavenging of a small amount of particle-bound compound can account for >98% of wet deposition for insoluble organic pollutants. Gas-phase scavenging is important for the more soluble compounds such as HCH. (Author's abstract)
W89-04983

INTRA-URBAN PRECIPITATION QUALITY: HAMILTON, CANADA,
McMaster Univ., Hamilton (Ontario). Dept. of Geography.
For primary bibliographic entry see Field 5B.
W89-04984

COMPARATIVE STUDY OF THE PRECIPITATION ACIDITY IN TWO CITIES IN CANTABRIA (SPAIN) WITH DIFFERENT DEGREES OF INDUSTRIALIZATION,
Cantabria Univ., Santander (Spain). Dept. of Fundamental Physics.
For primary bibliographic entry see Field 5B.
W89-04991

CHEMISTRY OF PRECIPITATION NEAR A LIMESTONE BUILDING,
Antwerp Univ., Wilrijk (Belgium). Dept. of Chemistry.
For primary bibliographic entry see Field 5B.
W89-04996

CHEMICAL DEPOSITION OF A HIGH ELEVATION RED SPRUCE FOREST,
Tennessee Valley Authority, Muscle Shoals, AL.
For primary bibliographic entry see Field 5B.
W89-04999

EFFECT OF SIMULATED ACID RAIN ON NITROGENASE ACTIVITY IN THE LICHEN GENUS PELTIGERA UNDER FIELD AND LABORATORY CONDITIONS,
Aquatic Habitat Inst., Richmond, CA.
For primary bibliographic entry see Field 5B.
W89-05001

INFLUENCE OF RAIN AND EVAPORATION ON SALT INTRUSION IN ESTUARIES,
Euroconsult, Arnhem (Netherlands).
H. H. G. Savenije.
Journal of Hydraulic Engineering JHEND8, Vol. 114, No. 12, p 1509-1524, December 1988. 8 fig, 3 tab, 5 ref.

Descriptors: *Estuaries, *Saline water intrusion, *Evaporation rate, *Rainfall, Salinity, Net rainfall, Hydrologic models, Mathematical analysis, Gambia, Model studies.

The extent of salt intrusion in well-mixed estuaries is governed by the balance of outward advective transport by fresh water and inward dispersive salt transport. The influence of local evaporation and rainfall on the salinity of estuary water is generally neglected in salt intrusion models. In the Gambia estuary, it appears that the influence of rain and evaporation is important. The Gambia estuary, however, is special in that it has a large surface area and it is very long (400 km). The influence of evaporation on salt intrusion may be less important in other estuaries. A model is presented to simulate salt intrusion taking into account the effects of local rain and evaporation. It is recommended that, whenever a salt intrusion model is made for a certain estuary, nondimensional analysis is carried out to study the necessity for inclusion of the evaporation terms. (Author's abstract)
W89-05216

UPDATED ASSESSMENT OF NATIONAL WEATHER SERVICE 30-DAY AND 90-DAY FORECASTS FOR NEW JERSEY,
Cook Coll., New Brunswick, NJ. Dept. of Meteorology and Physical Oceanography.
R. P. Harnack.
Bulletin of the New Jersey Academy of Sciences, Vol. 33, No. 2, p 55-60, Fall 1988. 1 fig, 8 tab, 2 ref.

Descriptors: *Forecasting, *Weather forecasting, *New Jersey, *Statistical analysis, Evaluation, Air temperature, Precipitation, Prediction.

The national Weather Service 30-day and 90-day temperature and precipitation forecasts were verified to determine their levels of skill for the state of New Jersey. All forecasts were drawn from the 1974-86 period, and two samples were used: the entire period, and a subperiod consisting of mid-1982 to mid-1986. The overall sample percent correct forecast exceeded chance and persistence for 30-day temperature (46% correct for three-class forecasts) and precipitation (58% correct for two-class forecasts). On a seasonal basis, only the summer 30-day precipitation forecasts are worse than chance and generally seasonally stratified scores are also better than persistence. The best skill was seen for winter forecasts (54% and 71% correct for temperature and precipitation respectively) and the frequency of two-class temperature errors was very small (4.4%). The two-class 90-day forecasts were either close to or below chance expectation for temperature (52%) and precipitation (42%). Again, winter forecasts were best for temperature, though summer was best for precipitation. No detectable forecast skill trends were found, which when considered with the overall skill calculated, suggests caution in the use of long-range forecasts especially at times of year when the skill found was low. (Author's abstract)
W89-05238

EFFECT OF RANDOM PRECIPITATION TIMES ON THE SCAVENGING RATE FOR TROPOSPHERIC NITRIC ACID,
National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center.
For primary bibliographic entry see Field 5B.
W89-05243

PRECIPITATION COMPOSITION AT CAPE GRIM, 1977-1985,
Commonwealth Scientific and Industrial Research Organization, Aspendale (Australia). Div. of Atmospheric Research.
For primary bibliographic entry see Field 5A.
W89-05244

UNUSUAL EXAMPLE OF FREEZING RAIN,
Meteorological Office, Guetersloh (Germany, F.R.).
D. W. Turner, and D. J. Marriott.
Meteorological Magazine MTMGA5, Vol. 117, No. 1393, p 255-257, August 1988. 2 fig.

Descriptors: *Ice formation, *Freezing rain, *Precipitation, *Weather, *Weather data collection, *Rain, *Freezing, West Germany, Meterological data collections, Air masses, Atmospheric water.

Freezing rain, while not unknown, is rare over western Europe and is nearly always a transitory feature. A single freezing rain event, which occurred in a narrow band probably no more than 30 km wide, over northern areas of the Netherlands and the Federal Republic of Germany, is described, with its attendant synoptic situation. This occurrence over north Germany was rare in its extended duration of over 9 hours. Considerable damage to tress, power and telephone lines resulted. The event illustrates vividly not only the ability of cold continental air to persist at the surface, despite the apparent encroachment of warm air, but also the marked difference between the cooling rates of grass and solid surfaces. (Friedmann-PTT)
W89-05311

RAIN-SNOW BOUNDARIES AND FREEZING PRECIPITATION IN CANADIAN EAST COAST WINTER STORMS,
Atmospheric Environment Service, Downsview (Ontario). Cloud Physics Research Div.
R. E. Stewart, and L. M. Patenaude.
Atmosphere-Ocean ATOCDA, Vol. 26, No. 3, p 377-398, September 1988. 12 fig, 5 tab, 17 ref.

Descriptors: *Freezing rain, *Rain, *Precipitation, *Snow, *Storms, *Canada, *Meterological data collection, Weather data collections, Atmospheric physics, Blizzards.

Fourteen rain-snow boundaries and freezing precipitation episodes within Canadian East Coast winter storms were examined. Radar, sounding, and surface observations were used to study the characteristics of these features. Rain-snow boundaries and freezing precipitation episodes are coupled phenomena. The deepest radar echoes and the heaviest precipitation generally occurred in the adjacent snow region, and surface wind shifts typically were associated with the transition to rain. A conceptual model of the processes in the vicinity of a rain-snow boundary and a freezing precipitation region was developed. Enhanced updrafts in the snow region gave rise to the observed enhanced snow. The trailing region of drizzle and/or light rain, sometimes supercooled, is associated with subsidence. Symmetric instability may be occurring in these rain-snow boundary and freezing precipitation cases. Several of the storms that were studied were undergoing rapid deepening. In each of these cases, the main updraft region was associated with the rain-snow boundary and freezing precipitation region. Understanding rapid deepening will, therefore, also require knowledge of the coupling of rain-snow boundaries with episodes of freezing rain. (Friedmann-PTT)
W89-05318

INFLUENCE OF THE OCEAN ON THE CHEMISTRY OF PRECIPITATION IN NOVA SCOTIA,
Technical Univ. of Nova Scotia, Halifax. Centre for Water Resources Studies.
J. K. Underwood, D. H. Waller, and D. Thirumurthi.
Atmosphere-Ocean ATOCDA, Vol. 26, No. 3, p 467-479, September 1988. 4 fig, 1 tab, 34 ref.

Descriptors: *Acid rain, *Water chemistry, *Water pollution sources, *Precipitation, *Chemistry of precipitation, *Nova Scotia, *Meteorological data collection, Rain, Snow, Hydrogen ion concentration, Marine climates, Cations, Anions.

Between the fall of 1977 and December 1980, > 800 samples of precipitation were collected at 9 rural locations across Nova Scotia. Average ph was 4.61, and an average conductivity of 25 microS/cm confirmed the low ionic strength of rain and snow. Of all ions, chloride was the most abundant at 76 microequivalents/L (2.7 mg/L). Oceanic origins were perceived as the source for chloride as well as for Na, Mg, 51% of K, 21% of Ca, and 21% of SO4, and the sea collectively accounted for 66% of all ions in Nova Scotian precipitation. In contrast, the dominating ions in New York, New Hampshire, Ontario and Norway were H(+) and SO4. In Nova Scotia, chloride concentrations in rain (mg/L) are a function of distance D (km) from the coast and may be described by the equation Cl (mg/L) = 4.5 D to the -0.42 power. It indicates that Cl concentrations are reduced by about 50% within 0.5 km of the coast, and 80% within 5 km. The continental North American chloride data examined are also consistent with the relationship. The shape of the chloride curve is similar to curves others have developed from rain and lake water chemistry observations in Holland and the United Kingdom, although those, and other European data, indicate that the marine influence is less pronounced in northeastern North America. The marine influence of precipitation chemistry on Nova Scotia has a maximum seasonal amplitude during the winter. (Author's abstract)
W89-05319

1986 DROUGHT IN THE SOUTHEASTERN UNITED STATES: HOW RARE AN EVENT WAS IT,
Lamont-Doherty Geological Observatory, Palisades, NY.
E. R. Cook, M. A. Kablack, and G. C. Jacoby.
Journal of Geophysical Research (D) JGRDE3, Vol. 93, No. D11, p 14,257-14,260, November 20, 1988. 2 fig, 1 tab, 19 ref. NSF Div. of Climate Dynamics Grant ATM 85-25188.

Descriptors: *Dendrochronology, *Paleohydrology, *Paleoclimatology, *Drought, *Frequency analysis, *History, Moisture deficiency, Trees, Planning.

The recent drought in the southeastern United States was the most severe episode of moisture deficiency to strike that area in the past 111 years, based on meteorological records. Using those records, the recurrence interval of this event has been estimated to be of the order of 100-200 years. A much longer history of drought occurrence is developed for this region, using tree-ring series of old-age trees growing in the southern Appalachian Mountains. This record, which extends back to 1700, indicates that the 1986 drought was unprece-

dented in its severity as a single-year event. On this basis, it is concluded that the 1986 drought is a very rare event, with a probably recurrence interval of at least 287 years. (Author's abstract)
W89-05348

VERY LOW PROBABILITY PRECIPITATION-FREQUENCY ESTIMATES: A PERSPECTIVE,
National Weather Service, Silver Spring, MD. Office of Hydrology.
F. Richards, and R. G. Wescott.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 243-252, 3 fig, 3 tab, 4 ref.

Descriptors: *Flood frequency, *Storm runoff, *Meteorological data, *Storms, *Statistical methods, *Probabilistic process, *Meteorological data collection, Precipitation, Prediction, Risks.

Attempts to quantitatively evaluate the level of risk associated with nuclear power plants have led to an increasing desire to assign probabilities to rare precipitation events. Because it was felt that purely statistical estimates of events with return periods greatly in excess of the period of record were susceptible to potentially unacceptable levels of uncertainty, an approach that combined statistical analysis with meteorological interpretation was taken to determine a 24-hr point precipitation amount judged to be associated with a 0.001 annual exceedance probability of occurrence (1000-yr event). The possibility of using joint probabilities associated with storm centering, depth area reduction, and storm intensity to determine the probability of average depths of precipitation over larger areas was also considered. The methodology is in an initial stage of development and should not be considered at this time for design applications. The distribution of storm decay coefficients may be regionally dependent. (See also W89-05642) (Author's abstract)
W89-05658

SQRT-EXPONENTIAL TYPE DISTRIBUTION OF MAXIMUM,
Kinki Univ., Higashiosaka (Japan). Dept. of Civil Engineering.
T. Etoh, A. Murota, and M. Nakanishi.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 253-264, 1 fig, 2 tab, 2 ref, 5 append.

Descriptors: *Statistical methods, *Meteorological data, *Rainfall intensity, *Parametric hydrology, Osaka, Japan, Mathematical studies, Statistical analysis, Outliers, Statistical models.

The square-root exponential type distribution of the maximum, or SQRT-ET-max distribution is presented, as the distribution to be applied to the annual maximum series of the total amount (or depth) of a single rainstorm. The distribution is theoretically derived, and is as simple in expression as conventional ones. It has two parameters and estimates them more stably than distributions with three or more parameters. It is as good as or superior to conventional three parameter distributions in overall fitness to frequency distributions of annual maximum depths of single rainstorms and rainfalls of about 24 hours. It is applied to various annual maxima made from the observed hourly rainfall sequence in Osaka, and those of daily rainfalls at major meteorological observatories throughout Japan. Five criteria are proposed to judge the goodness of distribution functions in practical applications: overall fitness, stability of the estimated parameters, reasonability of outliers, simplicity in expression, and theoretical background. It is shown that the SQRT-ET-max distribution is a highly plausible solution to the outlier problem of rainfalls of several to 48 hours duration. (See also W89-05642) (Author's abstract)
W89-05659

FREQUENCY ANALYSIS OF AUSTRALIAN RAINFALL DATA AS USED FOR FLOOD ANALYSIS AND DESIGN,
Bureau of Meteorology, Melbourne (Australia). Hydrology Branch.
R. P. Canterford, N. R. Pescod, H. J. Pearce, L. H. Turner, and R. J. Atkinson.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 293-302, 2 fig, 2 tab, 8 ref.

Descriptors: *Rainfall-runoff relations, *Statistics, *Duration analysis, *Rainfall intensity, *Mathematical Studies, *Rainfall frequency, *Rainfall duration, *Design floods,Computer models, Australia, Regression analysis.

The procedures used to obtain accurate, temporally and spatially consistent, intensity-frequency-duration (IFD) design rainfall data for Australia are discussed. Approximately 500,000 years of daily station annual maximum rainfalls (7,500 stations, average record length 65 years) and 12,000 years of pluviometer station data (600 stations, 20 years average record) for 12 durations were used in the development of the generalized IFD curves. These IFD design curves are used by design engineers and scientists as input to a wide range of design flood models and other environmental studies. The basic annual maximum rainfall data for durations of 6 minutes to 72 hours are fitted using a log-Pearson Type III distribution with a small positive regional skewness up to 0.7. Various regression techniques were used to estimate short duration data at daily read rain gauge sites. Six master charts of rainfall intensity for various durations and average recurrence intervals (ARI) covering all Australia are presented. From these six charts, plus a map of regionalized skewness, a full set of IFD curves can be obtained for any location using appropriate extrapolation and interpolation procedures. The IFD design curves extend from six minutes to 72 hours and ARI from one year to 100 years. Computerized Design IFD Rainfall System (CDIRS). CDIRS allows automatic determination of a full set of IFD curves (also in tabular form) for any location simply by supplying its latitude and longitude. (See also W89-05642) (Author's abstract)
W89-05662

STOCHASTIC FORMULATION OF STORM PATTERN AND RAINFALL INTENSITY-DURATION CURVE FOR DESIGN FLOOD,
Tokushima Univ. (Japan). Dept. of Construction Engineering.
M. Hashino.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 303-314, 6 fig, 2 tab, 4 ref.

Descriptors: *Duration analysis, *Rainfall-runoff relations, *Design storms, *Rainfall intensity, Flood forecasting, Probabilistic process, Probable maximum precipitation, Probability distribution, Intensity-duration relationship, Mathematical studies.

A stochastic single storm pattern, which preserves the stochastic properties of actual storm rainfall, was theoretically derived from Freund's bivariate probability density function. Two typical design storm patterns, the last and the central peaked types, are defined by three parameters: the reduced variate of the peak rainfall intensity, the autocorrelation index related to the autocorrelation coefficient of the rainfall intensities, and the conditional probability. Integration of the given stochastic design hyetograph gives a new conditional probability intensity-duration formula. The conditional probability intensity-duration curve is demonstrated by using actual hourly rainfall data. If there is a reliable intensity-duration curve, which is obtained from annual maximum series of data for different durations, a design storm pattern can be set for the last or the central peaked type of the conditional probability storm pattern corresponding to the usual intensity-duration curve. Design intensities for durations shorter than 1 hr can be estimated from the available hourly data. (See also W89-05642) (Author's abstract)
W89-05663

RAINFALL FREQUENCY STUDIES FOR CENTRAL SAUDI ARABIA,
King Saud Univ., Riyadh (Saudi Arabia). Dept. of Civil Engineering.
U. Sendil, and A. M. A. Salih.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 315-326, 4 fig, 5 tab, 12 ref.

Descriptors: *Rainfall frequency, *Statistics, *Frequency analysis, *Rainfall distribution, *Design storms, *Design floods, *Saudi Arabia, *Hydraulic structures, Regional floods, Gumbel distribution, Flood forecasting, Mathematical studies.

A frequency analysis was conducted on rainfall data for six stations in Central Saudi Arabia. The Gumbel type-a distribution was used to predict design storms for particular durations (10 min to 12 hr) and for particular return periods (2 to 50 yr). Analysis of data for each individual station as well as regional analysis was carried out using annual series. The area under study was divided into two zones by considering the rainfall and topographical characteristics, and depth-duration-frequency relationships were derived for each zone. These relationships are recommended for the design of hydraulic structures (storm sewers and drainage channels) in the area. Goodness of fit tests show that Gumbel's distribution fits satisfactorily to rainfall data of arid climates. Confidence limits ranged between 16 to 54% of the rainfall estimates for individual stations; they are reduced to about 20% in the case of regional analysis. More confidence can be attached to rainfall depth-duration-frequency relationships with extended length of data samples by regional analysis. The relationships should be used with caution for a region with high rainfall variability although the tests may show the region to be a homogeneous one, and for return periods greater than the total length of record. (See also W89-05642) (Davis-PTT)
W89-05664

ANALYSIS OF FLOOD OCCURRENCE THROUGH CHARACTERIZATION OF PRECIPITATION PATTERNS,
Kyushu Univ., Fukuoka (Japan). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W89-05665

SAMPLING THEORY OF THE BINARY RANDOM FIELD DECIDES THE RELATION ABOUT POINT AND PLANE OF THE EXTRA RAINSTORMS,
Yanbian Water Conservancy and Water Electricity Survey Designing Inst. (China).
Z. G. Pei.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 337-345, 1 fig, 2 tab, 2 ref.

Descriptors: *Rainfall frequency, *Flood frequency, *Statistical methods, *Rainstorms, *Flood forecasting, China, Rainfall field, Rainstorm point area, Typhoons.

The theoretical rainstorm point-area coefficient was studied and a correlation function sampling theorem was developed. Using band-limited white noise of low frequency and the moving average stochastic process, the correlation function sampling theorem reaches the same conclusion as the cut-off frequency. However, the cut-off frequency does not exist in the autoregressive model; thus the random process represented by the cut off frequen-

cy cannot be used. The sampling interval obtained from the correlation function makes the variance of the mean computed by the sampling value approach the real variance. The correlation function of the rainfall field was used to determine the average theoretical relation of the rainstorm point area coefficient. The largest rainstorm point area relation analyzed with the sampling principle is illustrated using data collected in the typhoon region of China. (See also W89-05642) (Davis-PTT)
W89-05666

ACID DEPOSITION AND THE ACIDIFICATION OF SOILS AND WATERS,
Colorado State Univ., Fort Collins. Dept. of Agronomy.
For primary bibliographic entry see Field 5C.
W89-05746

ASSESSMENT OF VARIABILITY IN PERFOMANCE OF WET ATMOSPHERIC DEPOSITION SAMPLERS,
Geological Survey, West Point, NY. Water Resources Div.
For primary bibliographic entry see Field 7B.
W89-05778

2C. Snow, Ice, and Frost

SNOW MELT AND RUNOFF IN AAPA-MIRE IN FINNISH LAPPLAND,
Helsinki Univ. of Technology, Espoo (Finland). Lab. of Hydrology and Water Resources Engineering.
For primary bibliographic entry see Field 2H.
W89-04702

FIRST RADIOCESIUM PROFILE AND SNOW COVER MASS MEASUREMENTS,
National Board of Waters, Helsinki (Finland). Hydrological Office.
For primary bibliographic entry see Field 5A.
W89-04744

TRACE ELEMENT STUDIES IN A REMOTE SCOTTISH UPLAND CATCHMENT: I. CHEMICAL COMPOSITION OF SNOW AND MELTWATERS,
University of East Anglia, Norwich (England). School of Environmental Sciences.
For primary bibliographic entry see Field 5B.
W89-04971

DISPLACEMENT OF CHERNOBYL FALLOUT IN SNOW LAYERS OF TEMPERATE ALPINE GLACIERS,
Innsbruck Univ. (Austria). Inst. of Medical Physics.
For primary bibliographic entry see Field 5B.
W89-05015

ROLE OF ADVECTION IN THE ENERGY BALANCE OF LATE-LYING SNOWFIELDS: NIWOT RIDGE, FRONT RANGE, COLORADO,
Indiana Univ., Bloomington. Dept. of Geology.
G. A. Olyphant, and S. A. Isard.
Water Resources Research WRERAO, Vol. 24, No. 11, p 1962-1968, November 1988. 4 fig, 14 ref.

Descriptors: *Tundra, *Alpine regions, *Snowmelt, *Advection, *Heat flow, Temperature, Humidity, Wind, Mathematical models, Colorado, Energy.

Measured profiles of temperature, humidity, and wind above alpine tundra are used as upwind boundary conditions in a numerical model for simulating turbulent transfer over late-lying snow. Resulting simulations indicate that (1) sensible heat flux comprises the major source of turbulent melt energy, although its relative importance vis-a-vis latent heat flux depends upon ambient weather conditions, and (2) advected heat contributes greatly to the energy heat balance of late-lying alpine snow. Near the leading edge of a snowfield, advection may contribute more than 30 MJ/sq m/d of melt energy on a very windy day and more than 12 MJ/sq m/d on a relatively windless day. The totals decrease to 5 MJ/sq m/d and 2 MJ/sq m/d at a distance of 1000 m from the leading edge. These findings suggest that the sensible heat flux may exceed net radiation as the major source of energy available for melting late-lying snow in windy alpine environments. (Author's abstract)
W89-05066

CHEMISTRY OF ATMOSPHERIC DEPOSITION, THE SNOWPACK, AND SNOWMELT IN THE TURKEY LAKES WATERSHED,
National Water Research Inst., Burlington (Ontario). Rivers Research Branch.
For primary bibliographic entry see Field 5B.
W89-05085

PREDICTING PIPELINE FROST LOAD,
Ontario Ministry of the Environment, Toronto.
M. B. Fielding, and A. Cohen.
Journal of the American Water Works Association JAWWA5, Vol. 80, No. 11, p 62-69, November 1988. 14 fig, 4 tab, 9 ref.

Descriptors: *Pipes, *Frost heaving, *Frozen ground, *Soil mechanics, Water mains, Mathematical equations, Prediction, Canada.

A study was undertaken to find a formula for predicting the additional load imposed on underground pipelines by soil freezing. It was concluded that a modified Boussinesq equation can be used to assess this load. Results also showed that frost affects the modulus of soil reaction and therefore the induced stress in flexible pipe. When soil freezes around the pipe, the modulus increases and stress in the pipe wall decreases. When soil is disrupted by thawing and ice around the pipe melts, the modulus decreases and stress increases. The level to which stress increases can be higher than when frost is just above the pipe crown. (VerNooy-PTT)
W89-05249

DIEL PATTERNS OF PHOTOSYNTHATE BIOSYNTHESIS BY PHYTOPLANKTON IN PERMANENTLY ICE-COVERED ANTARCTIC LAKES UNDER CONTINUOUS SUNLIGHT,
Montana State Univ., Bozeman. Dept. of Biology.
For primary bibliographic entry see Field 2H.
W89-05296

RAIN-SNOW BOUNDARIES AND FREEZING PRECIPITATION IN CANADIAN EAST COAST WINTER STORMS,
Atmospheric Environment Service, Downsview (Ontario). Cloud Physics Research Div.
For primary bibliographic entry see Field 2B.
W89-05318

RECENT GROWTH OF GULKANA GLACIER, ALASKA RANGE, AND ITS RELATION TO GLACIER-FED RIVER RUNOFF,
L. R. Mayo, and D. C. Trabant.
IN: Selected Papers in the Hydrologic Sciences 1986. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. Water-Supply Paper 2290. 1986. p 91-99, 7 fig, 1 tab, 10 ref.

Descriptors: *Alaska Range, *Gulkana Glacier, *Glacier mass balance, *Glaciohydrology, *Climatology, *Runoff, Glacial streams.

A hydrologically important shift in climate within the past decade is indicated for the Alaska Range, a glacierized region of relatively high river runoff rates. From 1910 to 1976, Gulkana Glacier thinned and receded. Water released from glacier storage during this period augmented river runoff. Since 1976 the glacier has thickened in the accumulation zone, has thinned slightly in the ablation zone, and is approaching a state of glacier mass and ice-flow equilibrium. The long recession apparently is ended. Recent moraines indicate that all other glaciers in the Alaska Range behaved similarly, which suggests that climatic variations affecting Gulkana are widespread. River flow increased during the recent period of glacier growth, suggesting that this growth was caused by increased precipitation. The hypothesis that glacier growth in the Alaska Range could signal a period of diminished streamflow is not supported. (See also W89-05586) (Author's abstract)
W89-05593

MANAGEMENT SIGNIFICANCE OF BIOAVAILABLE PHOSPHORUS IN URBAN RUNOFF,
Washington Univ., Seattle. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5C.
W89-05782

2D. Evaporation and Transpiration

WATER RESOURCES OF THE CLARKS FORK YELLOWSTONE RIVER VALLEY, MONTANA,
Geological Survey, Helena, MT. Water Resources Div.
For primary bibliographic entry see Field 2E.
W89-04688

MODELLING FOREST WATER CONSUMPTION IN THE NETHERLANDS,
Groningen Rijksuniversiteit (Netherlands). Dept. of Physical Geography.
A. J. Dolman, and S. Nonhebel.
Agricultural Water Management AWMADF, Vol. 14, No. 1-4, p 413-422, August 1988. 2 fig, 4 tab, 28 ref.

Descriptors: *Forests, *Forest hydrology, *Water use, *Natural use, *Evapotranspiration, *Hydrologic models, Water yield, The Netherlands.

The water consumption of oak, beech, spruce and pine forest is predicted from routinely measured meteorological data for five locations in the Netherlands. Differences in water consumption are found to be primarily a result of differences in interception loss. Predicted interception loss was found to depend quite strongly on the type of model used. The uncertainty of prediction of above canopy vapor pressure deficit remains a weak feature of the interception models. If the vapor pressure deficit and windspeed were not corrected, the interception losses would be much higher. Simultaneous observations of evaporation fluxes above grass and forest and inclusion of planetary boundary layer feedback mechanisms may in the near future present a solution to this problem. Differences in water yield between forests are likely a result of different interception losses. These differences are primarily a result of different saturation storage capacities and height as the latter determines the aerodynamic conductance in the Penman-Monteith equation. Transpiration estimates are relatively low as compared to the value of around 300 mm for forests in central Europe. Predicted transpiration for the stations at the coast and Eelde are lower than for the stations located further inland. The reverse holds for the predicted interception losses. These effects will probably reflect differences in climatological conditions between the stations. Over five years of simulated data the amount of water transpired was almost constant and independent of yearly gross precipitation, whereas the amount of interception loss was an almost constant fraction of gross precipitation. (Vernooy-PTT)
W89-05146

INFLUENCE OF RAIN AND EVAPORATION ON SALT INTRUSION IN ESTUARIES,
Euroconsult, Arnhem (Netherlands).
For primary bibliographic entry see Field 2B.
W89-05216

ESTIMATION OF THE NETT HEAT FLUX ON WATER SURFACES,
British Hydromechanics Research Association,

Cranfield (England).
G. J. Pollard.
The British Hydromechanics Research Association, Bedford, England. Report No. TN 2148, February 1984. 31p, 1 fig, 8 ref, 3 append.

Descriptors: *Heat flow, *Evaporation, *Water surface profiles, *Thermodynamics, Solar radiation, Atmospheric radiation, Water temperature, Evaporation, Heat transfer, Estimating, Conduction.

A water surface may gain heat from solar and/or atmospheric radiation and lose heat by long-wave radiation, evaporation, and/or conduction. An expression for each of these components is provided and its derivation explained in this report. The normal range of values of each component are tabulated, and worked examples are provided to illustrate the use of the expressions for a water surface in the field, and to gain some idea of the environmental effect of waste heat disposal. This study illustrates that good results can be expected when predicting heat fluxes in the field. Although values of net incident solar radiation are reckoned to be no better than 15% accurate, the expression for net incident atmospheric radiation is supposedly accurate to within 5%, and that for long-wave radiation from the water surface depends almost entirely on how representative a value of surface water temperature (T sub s) is obtainable - presumably T sub s is varies somewhat over a large water surface - but if T sub s is uniform, then a value of 1% is in order. Although no direct value for the accuracy of evaporative heat flux is quoted in other studies, there is an implication of accuracy of 10% or better. The order of magnitude of conductive heat flux is generally such that any reasonable estimate of its value is acceptable. (Lantz-PTT)
W89-05748

WATER USE BY SALTCEDAR AND BY REPLACEMENT VEGETATION IN THE PECOS RIVER FLOODPLAIN BETWEEN ACME AND ARTESIA, NEW MEXICO,
Geological Survey, Lakewood, CO. Water Resources Div.
For primary bibliographic entry see Field 3B.
W89-05775

2E. Streamflow and Runoff

TIME-SERIES ANALYSIS OF EDWARDS AQUIFER SPRINGS IN COMAL COUNTY, TEXAS,
SRH Associates, Inc., Portland, OR.
For primary bibliographic entry see Field 2F.
W89-04592

GROUND-WATER AND SURFACE-WATER DATA FOR FREDERICK COUNTY, MARYLAND,
Maryland Geological Survey, Baltimore.
For primary bibliographic entry see Field 7C.
W89-04632

ANNUAL REPORT TO THE PECOS RIVER COMMISSION ON INVESTIGATIONS BEING MADE IN NEW MEXICO AND TEXAS.
Geological Survey, Albuquerque, NM. Water Resources Div.
For primary bibliographic entry see Field 7C.
W89-04633

ANNUAL REPORT TO THE PECOS RIVER COMMISSION ON INVESTIGATIONS BEING MADE IN NEW MEXICO AND TEXAS.
Geological Survey, Albuquerque, NM. Water Resources Div.
For primary bibliographic entry see Field 7C.
W89-04634

HYDROLOGY OF THE DEVILS LAKE BASIN, NORTHEASTERN NORTH DAKOTA,
Geological Survey, Bismarck, ND. Water Resources Div.
For primary bibliographic entry see Field 2H.
W89-04637

LONG-TERM STREAMFLOW STATIONS IN FLORIDA, 1980,
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W89-04640

STREAMFLOW CHARACTERISTICS OF MOUNTAIN STREAMS IN THE UPPER YELLOWSTONE RIVER BASIN IN MONTANA,
Geological Survey, Helena, MT. Water Resources Div.
C. Parrett.
Montana Department of Natural Resources and Conservation, Energy Division, 1985. 22p, 4 fig, 11 tab, 4 ref.

Descriptors: *Water resources data, *Data collections, *Streamflow, *Mountains, *Yellowstone River, *Montana, Stream discharge, Flow velocity, Flow profiles, Mathematical studies, Drainage, Precipitation.

Once-monthly streamflow measurements were used to estimate long-term mean annual discharge, mean monthly discharge, and various points on the flow-duration curve for 17 sites in the upper Yellowstone River basin in Montana. The estimated average error when estimating long-term mean annual discharge and various discharges on the flow-duration curve was + or - 20% at the measurement sites. The estimated average error when estimating long-term mean monthly discharge at the measurement sites, together with data from one gaging station, were used to develop a map showing the variability of mean annual runoff in the study area. Data from the measurement sites plus data from one gaging station were used to develop regression equations relating mean annual discharge to drainage area and precipitation and equations relating flows of 10-, 20-, 30-, 40-, 50-, 60-, 70-, 80-, 90-, and 95-percent exceedance probability to mean annual discharge. The coefficient of determination for the best equation for predicting mean annual discharge was 0.896. The coefficients of determination for the equations for flows of various exceedance percentages ranged from 0.616 to 0.948. (Author's abstract)
W89-04643

WATER RESOURCES OF THE BIG HOLE BASIN, SOUTHWESTERN MONTANA,
Montana Bureau of Mines and Geology, Butte.
J. F. Levings.
Montana College of Mineral Science and Technology Memoir 59, 1986. 72p, 20 fig, 6 tab, 51 ref.

Descriptors: *Water resources data, *Montana, *Big Hole River, *Water resources, *Water quality, *Water supply, Aquifers, Groundwater budget, Transmissivity, Precipitation, Hydrologic studies, Chemical analysis, Hydrogen ion concentration, Irrigation water, Sodium bicarbonate, Iron, Stream discharge, Cattle, Domestic water.

The Big Hole basin is a partly glaciated, intermontane valley situated in southwestern Montana. The Big Hole River and its tributaries provide the primary source of water for ditch irrigation of abundant pasture lands in the basin. Nearly all domestic and stock wells obtain water from Tertiary and Quaternary sedimentary rocks underlying the valley floor. An adequate supply of water for domestic- and stock-watering needs is generally available within the top 125 feet of the sedimentary basin aquifer system, which may be as much as 1,000 ft thick. Wells in the Tertiary sedimentary rocks have specific capacities ranging from 0.2 to 83.3 gal/min/ft of drawdown, with the median value corresponding to a transmissivity of about 450 sq ft/day. Wells in Quaternary glacial-outwash deposits have specific capacities ranging from 1.0 to 14.5 gal/min/ft and those in Quaternary alluvium range from 1.1 to 5.3 gal/min/ft. Similar median values of specific capacity for both deposits correspond to a transmissivity of about 550 sq ft/day. Mean annual precipitation over the 1,267 sq mi watershed is 22.8 inches. Mean annual streamflow of the Big Hole River upstream from Mudd Creek has been estimated at 569 cu ft/sec using a method of streamflow correlation. Much of the 16.7-inch annual difference between precipitation input and stream outflow is most likely due to evapotranspiration. The chemical quality of surface water is generally very good for most uses. Streamflow is characterized by a calcium bicarbonate or calcium-sodium bicarbonate type water, and by small concentrations of dissolved solids (13 to 109 mg/L) that are associated with a small buffering capacity. The chemical quality of groundwater is generally good for domestic needs, except for the staining problems caused by large concentrations of dissolved iron in some wells. Groundwater from sampled wells also is suitable for crop irrigation. Water in the shallow wells generally is of a calcium bicarbonate or calcium-sodium bicarbonate type, with a pH near neutral. Water from deeper wells has a more basic pH and is similar in composition to the sodium bicarbonate type water flowing from Jackson Hot springs. The most likely explanation for anomalous sodium bicarbonate type water in a few shallow wells is rapid upwelling of deeply circulated groundwater along very permeable faults or fracture zones. (Author's abstract)
W89-04645

WATER RESOURCES OF LAKE CREEK VALLEY, NORTHWESTERN MONTANA,
Montana Bureau of Mines and Geology, Butte.
G. W. Levings, R. F. Ferreira, and J. H. Lambing.
Montana College of Mineral Science and Technology Memoir 56, 1984. 81p, 7 fig, 16 tab, 2 sheets, 29 ref, append.

Descriptors: *Water resources data, *Data collections, *Lakes, *Lake Creek, *Water quality, *Water resources, Chemical analysis, Montana, Dissolved oxygen, Suspended solids, Flow profiles, Calcium bicarbonate, Hydrogen ion concentration, Phosphorus, Nitrogen, Groundwater quality, Ross Creek, Stanley Creek, Wills, Domestic water, Mountain lakes, Streams.

Lake Creek Valley is an intermontane valley in northwestern Montana bounded on the west and east by the Cabinet Mountains. Water for domestic use occurs in the glaciolacustrine deposits and alluvium. The general direction of water movement is from the sides of the valley toward Lake Creek, and localized areas have a northerly component of flow. The yields of 33 wells ranged from 0.15 to 53 gpm (gal/min) and averaged 20.6. The specific capacities of 21 wells ranged from 0.2 to 30 gpm/ft of drawdown and averaged 5.6. During 1980 and 1981, water samples were collected for chemical analysis from 34 wells. Concentrations of dissolved solids ranged from 27 to 289 mg/L. The groundwater in the valley is primarily a soft to moderately hard, calcium bicarbonate type, with magnesium occurring in significant quantities in the northern part of the valley. Flow in Lake Creek, the principal stream draining the valley, is perennial. The discharge at a continuous-record station at the mouth during 1945 to 1957 averaged 516 cu ft/sec and ranged from 2.0 to 3.250 cu ft/sec. The results of about 20 streamflow measurements on the two principal tributaries to Lake Creek ranged from 2.6 to 498 cu ft/sec on Ross Creek and 33 to 171 cu ft/sec on Stanley Creek. Chemical and suspended sediment samples were collected from Ross, Stanley and Lake creeks. Measured pH values generally were near neutral and showed little evidence of seasonal trends. Dissolved oxygen was at or near saturation in all samples. Dissolved-solids concentrations were small, ranging from 25 mg/L for Ross Creek to 58 mg/L for Lake Creek. The water type of the streams is calcium bicarbonate. Measured concentrations of total nitrogen and total phosphorus were consistently smaller than levels associated with domestic-waste contamination. The lakes have calcium bicarbonate water, although the concentration of magnesium in Savage Lake contributes significantly to the concentration of dissolved solids. Dissolved solids concentrations in Savage Lake ranged from 120 to 159 mg/L, which is about 3.5 times greater than concentrations in Bull and Schoolhouse lakes. (Lantz-PTT)

W89-04646

FLOODS IN LOUISIANA, MAGNITUDE AND FREQUENCY,
Geological Survey, Baton Rouge, LA. Water Resources Div.
F. N. Lee.
Louisiana Dept of Transportation and Development, Baton Rouge, Water Resources Technical Report No. 36, 1985. Fourth Edition. 30p, 5 fig, 5 tab , 1 plate, 18 ref.

Descriptors: *Floods, *Louisiana, *Flood frequency, Flood hydrographs, Flood peak, Regression analysis, Stream discharge, Drainage.

The magnitude and frequency of floods are presented for 287 streamflow-gaging sites in Louisiana and bordering sites in the adjacent states of Mississippi and Arkansas. Regression equations, using 217 of these sites that are basically natural and unaltered and with drainage areas less than 3,000 sq mi, were developed using multiple regression techniques and were used to estimate discharges for return periods of 2,5, 10, 25, 50, and 100 years. Accuracy of the estimated discharges range from + or - 35% to + or - 43%. The report includes data used in the analyses through the 1983 water year. Independent variables, defined as being significant as predictors, are contributing drainage area, main-channel slope, and a mean annual precipitation index. Discharge weighted on the basis of station discharge and regression discharge is recommended for use at gaged sites when the stream is basically natural and unaltered. Examples of use of the estimating techniques that were developed are given. Peak-discharge data for the return periods of 2, 5, 10, 25, 50, and 100 years are given for streamflow sites with drainage areas larger than 3,000 sq mi. Graphs of discharge versus drainage area are presented for the Red, Pearl, and Sabine Rivers. (Author's abstract)
W89-04654

WATER RESOURCES ACTIVITIES IN KENTUCKY, 1986.
Geological Survey, Louisville, KY. Water Resources Div.
For primary bibliographic entry see Field 7B.
W89-04658

WATER-RESOURCES DATA FOR THE LOWER JAMES RIVER, DICKEY, LAMOURE, AND STUTSMAN COUNTIES, NORTH DAKOTA,
Geological Survey, Bismarck, ND. Water Resources Div.
J. D. Wald, and P. K. Christensen.
North Dakota Water Resources Investigation 2, 1986. 491p, 2 fig, 7 tab, 1 plate, 20 ref.

Descriptors: *Water resources data, *James River, *Data collections, *North Dakota, *Hydrologic data collections, *Groundwater, *Surface water, Hydrologic models, Lithologic logs, Hydrographs, Test wells, Chemical analysis, Stream discharge.

To provide geologic and hydrologic data needed to define the hydrologic system and conceptual model of the flow system, water resources data for the lower James River in Dickey, LaMoure, and Stutsman Counties, North Dakota, were collected. These data include records of wells and test holes, locations of miscellaneous surface water data collection sites, water levels in selected wells, lithologic logs of selected wells and test holes, chemical analyses of groundwater and surface water, surface water elevations, and surface water discharge measurements. (Author's abstract)
W89-04664

CHEMISTRY OF A TROPICAL RAIN FOREST STREAM: CHANGES ALONG AN ALTITUDINAL GRADIENT,
Center for Energy and Environment Research, San Juan, PR.
For primary bibliographic entry see Field 2K.
W89-04670

WATER RESOURCES OF THE CLARKS FORK YELLOWSTONE RIVER VALLEY, MONTANA,
Geological Survey, Helena, MT. Water Resources Div.
J. F. Levings.
U.S. Geological Survey Hydrogeologic Map 8, 1986. 10p, 5 tab, 3 maps, 15 ref.

Descriptors: *Water resources data, *Groundwater budget, *Surface waters, *Data collections, Clarks Fork Yellowstone River, Maps, Suspended sediments, Water quality, Water analysis, Wells, Surveys, Irrigation water, Domestic water.

The Clarks Fork Yellowstone River originates in the Beartooth Mountains and Absaroka Range of Montana and Wyoming. The river flows about 50 miles east and northeast in Wyoming, then flows an equal distance north-northeast from the State line to Laurel, Montana, where it empties into the Yellowstone River. In its downstream reaches, the Clarks Fork flows through an alluvial valley that ranges from about 1 to 3 miles in width. Most domestic water supplies in this valley are derived from wells completed in the alluvial aquifer; some wells are completed in bedrock aquifers if alluvium is not present or is unproductive. Crops grown in the valley are irrigated mainly with surface water diverted from the Clarks Fork and some of its major tributaries. The Clarks Fork transports large loads of suspended sediment from spring runoff and from intense local summer storms. A 1-year study was conducted to collect information about the thickness and extent of the alluvial aquifer, the altitude and configuration of the potentiometric surface in the alluvial aquifer, the quantity and variation in streamflow and suspended sediment, and the chemical quality of ground and surface water. To accomplish these objectives, 37 wells were inventoried and 43 samples of groundwater were collected for water quality analysis. Thirty-two holes were augered; some were cased and some had recorders installed for water level observation. Daily sediment stations were operated by the U.S. Geological Survey. Quarterly samples also were collected at these stations for water quality analysis. Water and suspended sediment samples were collected for analysis from selected diversion canals, ditch return flows, and the Clarks Fork and its tributaries. Information collected during the well inventory and observation-well drilling, and the analytical results of groundwater quality samples are tabulated in an accompanying pamphlet. (Lantz-PTT)
W89-04688

STREAMFLOW RESPONSE FROM AN OMBROTROPHIC MIRE,
North Central Forest Experiment Station, Grand Rapids, MN. Forestry Sciences Lab.
E. S. Verry, K. N. Brooks, and P. K. Barten.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu, Finland, 6-8 June 1988. Vol. 1. The Academy of Finland, Helsinki, Finland. 1988. p 52-59, 6 fig, 12 ref.

Descriptors: *Mires, *Rainfall-runoff relationships, *Streamflow, *Marshes, *Wetlands, *Topography, *Peat bogs, Water table fluctuations, Reservoirs, Flood frequency, Maximum flow, Peat, Hydrologic models, Comparison studies, Rainstorms, Specific yield, Flow discharge, Flood peak.

Streamflow response to a rainstorm exceeding a 100-year return interval is documented in relation to the peat profile and microtopography. The water table:discharge relation is corrected for specific yield and found to closely parallel the stage:discharge relationship for a level reservoir for flows up to a 25-year return interval. A faster water table:discharge relation occurs at higher flows when the mire develops wedge storage in the completely flooded, channel-like lagg around 2/3 of the mire perimeter. Flood frequency analysis was used to estimate a 25-year return interval peak flow of 350 liters per second per sq. km for a 10-hectare basin. (See also W89-04689) (Author's abstract)
W89-04698

SNOW MELT AND RUNOFF IN AAPA-MIRE IN FINNISH LAPPLAND,
Helsinki Univ. of Technology, Espoo (Finland). Lab. of Hydrology and Water Resources Engineering.
For primary bibliographic entry see Field 2H.
W89-04702

SEASONAL VARIATION IN STREAMFLOW RECESSIONS IN THE MIRE COMPLEX KOMOSSE, SOUTHERN CENTRAL SWEDEN,
Royal Inst. of Tech., Stockholm (Sweden). Institutionen foer Kulturteknik.
For primary bibliographic entry see Field 2H.
W89-04703

CONTRIBUTIONS TO THE STUDY OF PEATLANDS INFLUENCE ON MAXIMUM FLOW,
Institutul de Meteorologie si Hidrologie, Bucharest (Romania).
P. Serban, V. A. Stanescu, and M. Simota.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu, Finland, 6-8 June 1988. Vol. 1. The Academy of Finland, Helsinki, Finland. 1988. p 92-99, 5 fig, 4 ref.

Descriptors: *Rainfall-runoff relationships, *Peat bogs, *Maximum flow, *Streamflow, *Runoff, *Mathematical models, Geomorphology, Rainfall intensity, Flood hydrographs, Rainfall-runoff relationships, Infiltration, Catchment areas, Unit hydrographs.

The physiographical conditions specific for peatlands basins induce a set of peculiarities in the runoff formation process (significant precipitation losses over the basin and a slower runoff concentration). In order to emphasize these peculiarities a comparison between flood characteristics recorded in two adjacent basins of similar morphometric characteristics was established. One of the two basins has large peatlands (A), while the other has no such lands (B). In order to simulate the hydrological behavior specific for the basins under consideration three mathematical models have been calibrated, i.e.: SSARR and PNET for effective rainfall determination and IMH for the variable unit hydrograph. Analysis of the results obtained shows that the precipitation losses in the peatlands being investigated are mainly due to a more significant water retention in the depressions of basin A (UDM = 5, where UDM is the maximum capacity city of the depressions in the reservoir) more significant than in the standard basin (UDM = 2) and to the delayed infiltration of the water stored in the depressions. Likewise, the subsurface flow is larger in basin A than in B. In simulating floodwaves the unit hydrograph method was used as determined using the IMH model. Three types of unit hydrographs were obtained for the two basins as a function of the rainfall intensity. The unit hydrographs of type I are determined by rainfalls of intensities 8-12 mm/h, the type II hydrographs by rainfalls of 4-7 mm/h, and the type III unit hydrographs by rainfalls of 1-3 mm/h intensity. The maximum values of the unit hydrograph are smaller in basin A than in B and the concentration time and the total duration are larger for the unit hydrograph in basin A than in B for any of the three types. (See also W89-04689) (Author's abstract)
W89-04704

RUNOFF FORMATION AND REGIME IN DRAINED PEATLAND FORESTS,
Akademiya Nauk SSSR, Moscow. Forest Research Lab.
S. E. Vompersky, and A. A. Sirin.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu, Finland, 6-8 June 1988. Vol. 1. The Academy of Finland, Helsinki, Finland. 1988. p 135-140, 4 fig, 3 ref.

Descriptors: *Forest hydrology, *Drainage effects, *Forest management, *Runoff, *Peat bogs, *Forest watersheds, *Wetlands, *Rainfall-runoff relationships, Forest hydrology, Drainage practices, Drain spacing, Swamps.

The paper presents peculiarities of summer (June-September) runoff formation and regime in drained peatland forests, on the basis of data obtained on experimental forestry drainage in the West-Dvina Experiment Station of the Forest Research Laboratory of the USSR Academy of Sciences (the Kalinin Region). Observations were carried out in the catchments of separate drains. Drain spacings and depth of drains were typical of forestry drainage practice. The catchment area varied from 4 to 10 ha. Runoff formation and regime were investigated in the drained peatland forests: (a) ombrotrophic pine bog with only atmospheric water input; and (b) eutrophic and mesotrophic hardwood-spruce mires and swamps with atmospheric and groundwater water-budget input caused by overland flow from the surrounding upland and groundwater discharge. Differences in runoff regime in the above catchments are caused by (1) natural- hydrological peculiarities, and (2) drainage parameters (drain spacing and depth of drains). The presence of groundwater input in water budget provides more stable runoff in summer. The decrease in drain spacing increases the sensitivity of runoff to rainfall, raising flood peaks. Under the conditions of overland flow from surrounding upland, the reclamation value of intercepting canals is comparable with that of drain canals. Under the conditions of groundwater discharge, digging of drains up to the depth of mineral ground entails appreciable increase in the runoff. (See also W89-04689) (Author's abstract)
W89-04708

IMPROVEMENT OF RUNOFF PRODUCING MODEL FOR U. S. 'SCS' METHOD,
Wuhan Inst. of Hydraulic and Electric Power Engineering (China).
S. J. Chen.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu, Finland, 6-8 June 1988. Vol. 1. The Academy of Finland, Helsinki, Finland. 1988. p 141-147, 6 ref.

Descriptors: *Hydrologic models, *Rainfall-runoff relationships, *Excess rainfall, Mathematical models, *Runoff forecasting, *Infiltration, Semiarid lands, Arid zone hydrology, Humid areas.

Problems with the Soil Conservation Service (SCS) runoff model are discussed along with improved models for runoff prediction. In the SCS model, runoff capacity should equal rainfall and the rate of practical infiltration should be a different value between rainfall and rainfall excess. Some physical problems in the mathematical equations of the original model are illustrated. Two runoff models are proposed to correct the shortcomings of the original SCS model - one for humid regions, the other for arid regions. In the new models, all factors having an effect upon rainfall excess are considered. Examples of computations using the proposed improvements to the SCS model are given. The SCS models for humid and arid regions appeared more rational in theory and more accurate in application than current models of runoff producing or exceeding infiltration. (See also W89-04689) (Geiger-PTT)
W89-04709

STUDY OF INTERRELATED SOIL-WATER, GROUND-WATER AND RIVER FLOWS,
Akademiya Nauk SSSR, Moscow. Inst. Vodnykh Problem.
M. G. Khublarian, and V. E. Putyrskiy.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu, Finland, 6-8 June 1988. Vol. 1. The Academy of Finland, Helsinki, Finland. 1988. p 155-163, 3 fig, 8 ref.

Descriptors: *Groundwater movement, *Soil water, *Streamflow, Forestry, *Wetlands, *Mathematical models, *Surface-groundwater relations, Hydrologic models, Seepage, Channel flow, Infiltration, Aeration zone, Agriculture.

The problems of studying groundwater dynamics, particularly in areas where the groundwater level is near the land surface involves examination of the relation between the water table and the zone of aeration. In addition to its scientific significance, this problem is of applied value for agriculture and forestry. The paper discusses the problems of studying water-exchange processes in the system river-groundwater with the use of mathematical modeling. A quasi-three-dimensional non-steady and non-linear hydrodynamic model of the relation between surface-and groundwater numerically realized, has been developed. The contribution of bank and bed components to the seepage of rivers is shown in a wetland area in the near-channel zone of the river (or canal). (See also W89-04689) (Author's abstract)
W89-04711

PRELIMINARY EFFECTS OF FOREST DRAINAGE IN ALBERTA, CANADA ON GROUNDWATER TABLE LEVELS AND STREAM WATER QUALITY,
Northern Forest Research Centre, Edmonton (Alberta).
For primary bibliographic entry see Field 4C.
W89-04716

IMPACTS OF DRAINAGE FOR FORESTRY ON RUNOFF AND WATER CHEMISTRY,
Sveriges Lantbruksuniversitet, Uppsala. Dept. of Forest Soils.
For primary bibliographic entry see Field 4C.
W89-04717

EFFECTS OF SILVICULTURAL MEASURES ON PRIMARY PRODUCTION IN FOREST BROOKS,
Joensuu Univ. (Finland). Dept. of Biology.
For primary bibliographic entry see Field 4C.
W89-04721

ROLE OF THE STRUCTURE OF INTRASWAMP BASINS FOR RIVER RUNOFF FORMATION FROM SWAMPS,
Leningrad State Univ. (USSR). Faculty of Geography.
For primary bibliographic entry see Field 2H.
W89-04739

RECONNAISSANCE OF THE WATER RESOURCES OF THE MCALESTER AND TEXARKANA QUADRANGLES, SOUTHEASTERN OKLAHOMA,
Geological Survey, Oklahoma City, OK. Water Resources Div.
For primary bibliographic entry see Field 7C.
W89-04832

INTENSIVE SURVEY OF THE ILLINOIS RIVER (ARKANSAS AND OKLAHOMA) IN AUGUST 1985,
Environmental Research Lab.-Duluth, MN.
J. H. Gakstatter, and A. Katko.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-117056. Price codes: A06 in paper copy, A01 in microfiche. Report No. EOA/600/3-87/040, October 1987. 141p, 21 fig, 16 tab, 19 ref, 11 append.

Descriptors: *Rivers, *Water pollution sources, *Illinois River, *Arkansas, *Oklahoma, *Water quality, Phosphorus, Turbidity, Algae, Phytoplankton, Ecological effects, Fate of pollutants.

The Illinois River originates in Northwest Arkansas and drains to the southwest into Oklahoma, eventually joining the Arkansas River. The Illinois is impounded at Lake Frances, a small, shallow reservoir near the Arkansas-Oklahoma border and again at Lake Tenkiller Ferry, near its confluence with the Arkansas River. A water quality survey of the Illinois River Basin was conducted August 16-29, 1985, in response to concerns that water clarity had decreased in the lower reach which is designated as an Oklahoma scenic river. The survey results demonstrated that background phosphorus concentrations in the basin were very low; however, Osage Creek, which carried treated wastewater from two Arkansas municipalities, typically had total phosphorus concentrations much higher than background and substantially increased total phosphorus in the Illinois River above Lake Frances. Water in the Illinois River, entering Lake Frances, was somewhat turbid from inorganic particles of natural origin and rich in phosphorus. The high phosphorus levels supported substantial algal growth in Lake Frances and the phytoplankton, combined with suspended inorganic particles, diminished water clarity in the river for 20 miles or more below the Lake Frances dam. (Author's abstract)
W89-04872

EFFECTIVENESS OF BMPS FOR STORMWATER MANAGEMENT IN URBANIZED WATERSHEDS,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5G.
W89-04873

IMPROVED STREAMFLOW AND WATER QUALITY MONITORING USING A MICROPROCESSOR-BASED SYSTEM,
Forest Service, Ogden, UT. Intermountain Research Station.
For primary bibliographic entry see Field 7B.
W89-04876

COST EFFECTIVENESS OF THE STREAM-GAGING PROGRAM IN MISSOURI,
Geological Survey, Rolla, MO. Water Resources Div.
For primary bibliographic entry see Field 7B.
W89-04898

SEDIMENTATION AND WATER QUALITY IN THE WEST BRANCH SHADE RIVER BASIN, OHIO, 1983-85,
Geological Survey, Columbus, OH. Water Resources Div.
For primary bibliographic entry see Field 5B.
W89-04901

LOW STREAMFLOW CONDITIONS IN THE WESTERN UNITED STATES DURING 1987,
Geological Survey, Portland, OR. Water Resources Div.
L. L. Hubbard.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 87-4267, 1987. 29p, 7 fig, 3 tab, 11 ref.

Descriptors: *Streamflow, *Low flow, *California, *Nevada, *Idaho, *Oregon, *Washington State, Drought, Flow discharge, Precipitation, Snow, Temperature, Data collections, Water resources data.

Drought conditions prevailed throughout the States of California, Nevada, Idaho, Oregon, and Washington during the summer of 1987. Streamflows were the lowest since the drought of 1977. Many streams had less discharge in August-September 1987 than in August-September of 1977. At some sites flows for July, August, and September were the minimum ever recorded for those months. The reason for the low flows, which occurred in spite of near normal precipitation for the 1987 water year (October 1, 1986 to September 30, 1987) were low winter snowpack, unseasonably early melt of that snowpack, and prolonged periods of well-above-average temperatures. (Author's abstract)
W89-04902

FLOOD OF OCTOBER 1986 AT SEWARD, ALASKA,
Geological Survey, Anchorage, AK. Water Resources Div.
S. H. Jones, and C. Zenone.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 87-4278,

1988. 43p, 27 fig, 5 tab, 2 plates, 35 ref.

Descriptors: *Data collections, *Hydrologic data, *Runoff, *Floods, *Alaska, Alluvial fans, Rainstorms, Erosion, Landslides, Avalanches, Peak discharge, Surges, Small watersheds, Rainfall-runoff relationships, Flood frequency, Flood damage.

Broad areas along the lower Resurrection River and Salmon Creek as well as the surfaces of several adjacent alluvial fans in the Seward area were flooded as a result of the intensive rainstorm of October 9-11, 1986. Severe erosion took place through the steep gradient, mountain canyons and near the apex of the fans, while rock and debris were deposited on the distal parts of the fans. In Godwin, Lost, Box Canyon, Japanese, and Spruce Creek basins, and perhaps others, landslides or debris avalanches dammed the streams temporarily. Subsequent failure or overtopping of these dams led to 'surge-release' flooding; peak discharge of such a flood at Spruce Creek was 13,600 cu ft/sec, four times as great as any previously known maximum discharge from the basin and 2.5 times as great as the runoff rate from the debris dam. Flood discharges were determined indirectly--using the slope-area method--at ten high-gradient reaches on nine streams. Computed peak discharges for several small basins were the largest since records began in 1963. The largest rainfall-runoff rate unaffected by surge-release was 1,020 cu ft per sec per sq mi at Rudolph Creek, which has a drainage area of 1.00 sq mi. The 15.05 inches of rain that fell in one 24-hour period during the storm was assigned a recurrence interval of 100 years or greater. The length of the streamflow record available for most Seward area streams-25 years or less-is inadequate to reliably define flood frequency relations for recurrence intervals as great as 100 years. However, the slope-area determined discharge of Spruce Creek above the debris avalanche indicates a recurrence interval of a 100 years or greater. In addition, conventional flood-frequency analysis techniques are not applicable to peak discharges that are affected by surge-release phenomena. Large, damaging floods have repeatedly caused major damage in the Seward area, and the potential for catastrophic, debris-laden floods is an ever-present threat to areas bordering the many steep mountain streams. (Author's abstract)
W89-04905

COST EFFECTIVENESS OF THE U.S. GEOLOGICAL SURVEY'S STREAM-GAGING PROGRAM IN WISCONSIN,
Geological Survey, Madison, WI. Water Resources Div.
J. F. Walker, L. L. Osen, and P. E. Hughes.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-41125, 1987. 44p, 12 fig, 15 tab, 37 ref.

Descriptors: *Gaging stations, *Streamflow, *Gaging, *Cost analysis, *Wisconsin, Flow discharge, Stream gages, Streamflow forecasting, Model studies, Routing, Statistical methods, Evaluation, Optimization, Budgeting, Error analysis, Networks, Maintenance.

This report presents the results of a three-step evaluation of the stream-gaging program in Wisconsin. First, data uses and funding sources were identified for the 89 continuous-record gaging stations operated during the 1984 water year. Next, alternative methods of streamflow estimation were examined for three stations. A flow-routing model was used for two of the stations and a statistical model was used for the third. The modeled discharges did not compare well enough with observed discharges to warrant elimination of any of the stations. Finally, an optimization model was used to assess the cost effectiveness of the stream-gaging process. The annual budget, in 1984 dollars, for operating the 89 continuous-record gaging stations and 65 additional stations is $557,3000. Based on a Kalman-filter analysis, the theoretical average standard error of instantaneous discharge associated with the current practice of visiting the stations is 13.8%. This overall level of accuracy could be maintained with a budget of $518,6000 if stream-gaging activities were redistributed in an optimal fashion among the gaging stations. For the current budget, the theoretical average standard error would be reduced to 10.1% if the network is operated in an optimal fashion. Furthermore, the average standard error would be reduced to 7.3% if all missing record is eliminated and the network is operated optimally. A minimum budget of $510,000 is required to operate the program; a budget less than this does not permit proper service and maintenance of the gaging stations. At this minimum budget, the theoretical average standard error of instantaneous discharge is 14.4%. The maximum budget analyzed was $650,000 and resulted in an average standard of error of instantaneous discharge of 7.2%. (Author's abstract)
W89-04909

EFFECTS OF PROPOSED HIGHWAY EMBANKMENT MODIFICATIONS ON WATER-SURFACE ELEVATIONS IN THE LOWER PEARL RIVER FLOOD PLAIN NEAR SLIDELL, LOUISIANA,
Geological Survey, Baton Rouge, LA. Water Resources Div.
For primary bibliographic entry see Field 4C.
W89-04912

DISCHARGE RATINGS FOR CONTROL GATES AT MISSISSIPPI RIVER LOCK AND DAM 13, FULTON, ILLINOIS,
Geological Survey, Iowa City, IA. Water Resources Div.
For primary bibliographic entry see Field 8B.
W89-04916

LOUISIANA HYDROLOGIC ATLAS MAP NO. 1: MEAN ANNUAL RUNOFF IN LOUISIANA,
Geological Survey, Baton Rouge, LA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W89-04927

WATER QUALITY IN THE LOWER PUYALLUP RIVER VALLEY AND ADJACENT UPLANDS, PIERCE COUNTY, WASHINGTON,
Geological Survey, Tacoma, WA. Water Resources Div.
For primary bibliographic entry see Field 5B.
W89-04930

LOW-FLOW PROFILES OF THE UPPER OCMULGEE AND FLINT RIVER IN GEORGIA,
Geological Survey, Doraville, GA. Water Resources Div.
R. F. Carter, E. H. Hopkins, and H. A. Perlman.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4176, 1986. 239p, 1 fig, 13 ref.

Descriptors: *Waste-assimilative capacity, *Low flow, *Georgia, Drainage area, Carrying capacity, Assimilitive capacity.

This report provides low-flow information for use in evaluating the capacity of streams to supply withdrawals or to accept waste loads from potential new industries without exceeding the limits of State water-quality standards. The report is the first phase of a study of all stream basins north of the Fall Line in Georgia. It covers the Piedmont part if the Ocmulgee and Flint River basins. The low-flow characteristic presented is the minimum average flow for 7 consecutive days with a 10-year recurrence interval. The data are presented graphically as low-flow profiles (low flow as a function of distance along a stream channel) and as drainage-area profiles (drainage area as a function of distance along a stream channel). Low-flow profiles were constructed by interpolation or extrapolation from points of known low-flow data. Low-flow profiles are included for all stream reaches where low-flow data of sufficient accuracy are available to justify computation of the profiles. Drainage-area profiles are included for all stream basins larger than 5 sq mi. Flow records were not adjusted for diversions or other factors that cause measured flows to represent other than natural flow conditions. Profiles for 7-day minimum flows are omitted for stream reaches where natural flow is known to be significantly altered. (Author's abstract)
W89-04946

FLOOD CHARACTERISTICS FOR THE NISQUALLY RIVER AND SUSCEPTIBILITY OF SUNSHINE POINT AND LONGMIRE FACILITIES TO FLOODING IN MOUNT RAINIER NATIONAL PARK, WASHINGTON,
Geological Survey, Tacoma, WA. Water Resources Div.
L. M. Nelson.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4179, 1987. 18p, 2 plates, 7 fig, 7 tab, 9 ref.

Descriptors: *Glaciohydrology, *Glaciers, *Floods, *Rivers, *Washington, Mount Ranier, Flood flow.

Inundation from 25-, 50-, 100-, and 500-year floods at Sunshine Point and Longmire facilities and the Longmire visitors' center and ranger station generally is not a serious hazard as long as the existing dikes and banks of the Nisqually River and Tahoma Creek remain intact and flood capacities of the channels are maintained. However, average water velocities during floods are high (as much as 23 ft/sec) and the channel, banks, and some dikes are composed of unstable materials. Sunshine Point campground is particularly susceptible to flooding and damage from Tahoma Creek, and to a lesser extent from the Nisqually River, if large amounts of debris or rock material accumulate in the channels and change the flood elevation or courses of either stream. At Longmire flood inundation or damage from the Nisqually River is much less, but flooding is still possible. There, high ridges upstream protect the several park facilities from the river, but accumulations of debris or rock in the channel could cause flooding from overtopping of dikes or riverbanks. Glacial outburst floods are a matter of serious concern at both Sunshine Point campground and Longmire. Glacial outbursts can and have produced very large flood discharges and transported large quantities of debris and rock materials. Although none have been known to transport these materials from Tahoma Glacier as far as Sunshine Point campground, one in 1955 from Nisqually Glacier (estimated at 70,000 cu ft/sec near the glacier) did appreciably increase the magnitude of the water discharge at Longmire. For safety, campers and visitors need to be advised about the potential flood hazards at both facilities. (Author's abstract)
W89-04949

FLOODING OF DECEMBER 29, 1984 THROUGH JANUARY 2, 1985, IN NORTHERN NEW YORK STATE, WITH FLOOD PROFILES OF THE BLACK AND SALMON RIVERS,
Geological Survey, Albany, NY. Water Resources Div.
R. Lumia, P. M. Burke, and W. H. Johnston.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4191, 1987. 53p, 13 fig, 7 tab, 23 ref.

Descriptors: *Floods, *Snowmelt, *Flood damage, *New York, Flood recurrence interval, Gaging stations, Precipitation, Rivers.

Precipitation, snowmelt, and resultant flooding throughout northern New York from December 28 through January 2, 1985, were investigated through a detailed analysis of 56 precipitation stations, 101 stage and/or discharge gaging stations, and 9 miscellaneous measurement sites. Flood damage to property and roads and bridges exceeded $5 million. Lewis and Oswego Counties were declared Federal disaster areas, primarily a result of flooding of the Black River and Salmon River. Storm-precipitation and runoff maps show the storms' greatest intensity to have been over the Tug Hill and southwest Adirondack areas. Total rainfall from December 28 through Januar, 2 was

6.90 inches at Stillwater Reservoir but only 0.69 inches at Lake Placid. New peak discharges of record occurred at 17 gaging stations throughout northern New York, and the maximum discharge at 17 sites had recurrence intervals equal to or greater than 100 years. Computed inflows to 11 major lakes and reservoirs in northern New York indicate that significant volumes of water (as much as 5 inches of storm runoff at Stillwater Reservoir) were stored during the storm-runoff period. Maximum 1-day flood volumes at two gaging stations on the Black River had recurrence intervals greater than 100 years. To help evaluate the extent of flooding, 67 floodmarks were obtained along a 94-mile reach of the Black River from Dexter to Forestport, and several floodmarks were surveyed within major communities along the Salmon River. The floodmarks were obtained primarily near major bridges and dams along these rivers. (Author's abstract)
W89-04954

TECHNIQUES FOR SIMULATING FLOOD HYDROGRAPHS AND ESTIMATING FLOOD VOLUMES FOR UNGAGED BASINS IN CENTRAL TENNESSEE,
Geological Survey, Nashville, TN. Water Resources Div.
C. H. Robbins.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4192, 1986. 32p, 10 fig, 3 tab, 7 ref.

Descriptors: *Simulation analysis, *Model studies, *Tennessee, *Flood hydrographs, *Flood forecasting, *Statistical analyses, Regression analysis, Flood channels, Drainage area.

A dimensionless hydrograph developed for a variety of basin conditions in Georgia was tested for its applicability to central Tennessee streams by comparing it to a similar dimensionless hydrograph developed for central Tennessee streams. Statistical analyses were performed by comparing simulated (or computed) hydrographs, derived by application of the Georgia-study dimensionless hydrograph and the central Tennessee dimensionless hydrograph, with 163 observed hydrographs from 38 stations having a wide range of drainage area sizes and basin conditions, at 50% and 75% of their peak flow widths. Test results indicate the two dimensionless hydrographs are essentially the same. Using the Georgia-study dimensionless hydrograph, the standard error of estimate was +/-21.2% at the 50% of peak flow width and +/-24.8% at the 75% of peak flow width. Study results indicate the Georgia dimensionless hydrograph is applicable to central Tennessee streams. Equations for rural and urban basin lagtime were derived from multiple-regression analyses that relate lagtime to physical basin characteristics. At the 95% confidence level, channel length was significant for the rural basin equation and channel length and percentage of impervious area were significant for the urban basin equation. A regression equation that related flood volumes to drainage area size, peak discharge, and basin lagtime also was developed. The flood-hydrograph and flood-volume techniques are useful for estimating a typical (average) flood hydrograph and volume for any specified recurrence interval peak discharge at any ungaged stream site draining areas less than 500 sq mi in central Tennessee. (Author's abstract)
W89-04955

ESTIMATING PEAK DISCHARGES, FLOOD VOLUMES, AND HYDROGRAPH SHAPES OF SMALL UNGAGED URBAN STREAMS IN OHIO,
Geological Survey, Columbus, OH. Water Resources Div.
J. M. Sherwood.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4197, 1986. 52p, 12 fig, 12 tab, 21 ref.

Descriptors: *Urban hydrology, *Urban runoff, *Storm runoff, *Ohio, *Flood peak, *Streamflow forecasting, *Flood hydrographs, Regression analysis, Drainage area, Channel morphology, Streams.

Methods are presented for estimating peak discharges, flood volumes and hydrograph shapes of small (less than 5 sq mi) urban streams in Ohio. Examples of how to use the various regression equations and estimating techniques also are presented. Multiple-regression equations were developed for estimating peak discharges having recurrence intervals of 2, 5, 10, 25, 50, and 100 years. The significant independent variables affecting peak discharge are drainage area, main-channel slope, average basin-elevation index, and basin-development factor. Standard errors of regression and prediction for the peak discharge equations range from +/-37% to +/-41%. An equation also was developed to estimate the flood volume of a given peak discharge. Peak discharge, drainage area, main-channel slope, and basin-development factor were found to be the significant independent variables affecting flood volumes for given peak discharges. The standard error of regression for the volume equation is +/-52%. A technique is described for estimating the shape of a runoff hydrograph by applying a specific peak discharge and the estimated lagtime to a dimensionless hydrograph. An equation for estimating the lagtime of a basin was developed. Two variables--main-channel length divided by the square root of the main-channel slope and basin-development factor--have a significant effect on basin lagtime. The standard error of regression for the lagtime equation is +/-48%. The data base for the study was established by collecting rainfall-runoff data at 30 basins distributed throughout several metropolitan areas of Ohio. Five to eight years of data were collected at a 5-min record interval. The USGS rainfall-runoff model A634 was calibrated for each site. The calibrated models were used in conjunction with long-term rainfall records to generate a long-term streamflow record for each site. Each annual peak-discharge record was fitted to a Log-Pearson Type III frequency curve. Multiple-regression techniques were then used to analyze the peak discharge data as a function of the basin characteristics of the 30 sites. (Author's abstract)
W89-04959

FLOOD HAZARD ASSESSMENT OF THE HOH RIVER AT OLYMPIC NATIONAL PARK RANGER STATION, WASHINGTON,
Geological Survey, Towson, MD. Water Resources Div.
D. L. Kresch.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4198, 1987. 22p, 1 plate, 7 fig, 2 tab, 13 ref.

Descriptors: *Hoh River, *Flood hazard, *Flood forecasting, *Washington, *River flow, *Flow measurement, *Flow velocity, Hoh River, Avalanches.

Federal regulations require buildings and public facilities on Federal land to be located beyond or protected from inundation by a 100-year flood. Flood elevations, velocities and boundaries were determined for the occurrence of a 100-year flood through a reach, approximately 1-mi-long, of the Hoh River at the ranger station complex in Olympic National Park. Flood elevations, estimated by step-backwater analysis of the 100-year flood discharge through 14 channel and flood-plain cross sections of the Hoh River, indicate that the extent of flooding in the vicinity of buildings or public facilities at the ranger station complex is likely to be limited mostly to two historic meander channels that lie partly within loop A of the public campground and that average flood depths of about 2 feet or less would be anticipated in these channels. Mean flow velocities at the cross sections, corresponding to the passage of a 100-year flood, ranged from about 5 to over 11 ft/sec. Flooding in the vicinity of either the visitors center or the residential and maintenance areas is unlikely unless the small earthen dam at the upstream end of Taft Creek were to fail. Debris flows with volumes on the order of 100 to 1,000 cu yards could be expected to occur in the small creeks that drain the steep valley wall north of the ranger station complex. Historic debris flows in these creeks have generally traveled no more than about 100 yards out onto the valley floor. The potential risk that future debris flows in these creeks might reach developed areas within the ranger station complex is considered to be small because most of the developed areas within the complex are situated more than 100 yards from the base of the valley wall. Landslides or rock avalanches originating from the north valley wall with volumes potentially much larger than those for debris flows could have a significant impact on the ranger station complex. The probability that such landslides or avalanches may occur is unknown. Inspection of aerial photographs of the Hoh River valley revealed the apparent presence, along the ridge crest of the north valley wall, of ridge-top depressions--geologic features that are sometimes associated with the onset of deep-seated slope failures. However, evaluation of the potential landslide hazard associated with these depressions would require an onsite examination of the area by trained personnel. Such an effort was outside the scope of this study. (Author's abstract)
W89-04960

WATER QUALITY OF THE MALHEUR LAKE SYSTEM AND MALHEUR RIVER, AND SIMULATED WATER-QUALITY EFFECTS OF ROUTING MALHEUR LAKE WATER INTO MALHEUR RIVER, OREGON, 1984-85,
Geological Survey, Portland, OR. Water Resources Div.
For primary bibliographic entry see Field 5B.
W89-04963

RECONNAISSANCE OF GEOHYDROLOGIC AREAS AND IN 1981 LOW-FLOW CONDITIONS, WITHLACOOCHEE RIVER BASIN, SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT,
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-04964

STREAMFLOW AND WATER QUALITY OF THE GRAND CALUMET RIVER, LAKE COUNTY, INDIANA, AND COOK COUNTY, ILLINOIS, OCTOBER 1984,
Geological Survey, Indianapolis, IN. Water Resources Div.
For primary bibliographic entry see Field 5B.
W89-04965

DISCHARGE RATINGS FOR CONTROL STRUCTURES AT MCHENRY DAM ON THE FOX RIVER, ILLINOIS,
Geological Survey, Urbana, IL. Water Resources Div.
For primary bibliographic entry see Field 8B.
W89-04968

STREAMFLOW GAIN AND LOSS OF SELECTED STREAMS IN NORTHERN ARKANSAS,
Geological Survey, Little Rock, AR. Water Resources Div.
For primary bibliographic entry see Field 7C.
W89-04970

SUMMER PRIMARY PRODUCTIVITY AND ASSOCIATED DATA FOR FOUR INDIANA RIVERS,
Indiana Dept. of Environmental Management, Indianapolis. Water Quality Surveillance and Standards Branch.
For primary bibliographic entry see Field 5A.
W89-05003

STREAM-VARIABLE RESPONSE TO A CHANGE IN SURFICIAL GEOLOGY: MIDDLE FORK, BIG WALNUT CREEK, HENDRICKS COUNTY, INDIANA,
Indiana Univ.-Purdue Univ. at Indianapolis. Dept. of Geology.

For primary bibliographic entry see Field 2J.
W89-05004

PHOTOCHEMICAL DECOMPOSITION OF CARBAMATE PESTICIDES IN NATURAL WATERS OF NORTHERN GREECE,
Thessaloniki Univ., Salonika (Greece). Environmental Pollution Control Lab.
For primary bibliographic entry see Field 5B.
W89-05014

MINERAL COMPOSITION OF AZOLLA PINNATA IN RELATION TO COMPOSITION OF FLOODWATERS IN BANGLADESH,
Durham Univ. (England). Dept. of Botany.
For primary bibliographic entry see Field 3F.
W89-05025

CHANGES IN THE STRUCTURAL AND FUNCTIONAL COMPONENTS OF THE FISH COMMUNITY OF A SEASONAL RIVER,
Ibadan Univ. (Nigeria). Dept. of Zoology.
For primary bibliographic entry see Field 2H.
W89-05029

SPECIES RICHNESS OF AQUATIC MACROPHYTE COMMUNITIES IN CENTRAL CANADA,
Winnipeg Univ. (Manitoba). Dept. of Biology.
For primary bibliographic entry see Field 2H.
W89-05039

CHIRONOMIDS AS WATER QUALITY INDICATORS IN THE RIVER MIGNONE (CENTRAL ITALY),
Universita degli Studi 'La Sapienza', Rome (Italy). Dipt. di Biologia Animale e dell 'Uomo.
For primary bibliographic entry see Field 5A.
W89-05044

ABUNDANCE AND DISTRIBUTION OF BACTERIOPLANKTON IN THE GAMBIA RIVER, WEST AFRICA,
Michigan Univ., Ann Arbor. Great Lakes Research Div.
M. J. Healey, R. A. Moll, and C. O. Diallo.
Microbial Ecology MCBEBU, Vol. 16, No. 3, p 291-310, 1988. 5 fig, 7 tab, 25 ref. AID contract 685-0012-C-2158.

Descriptors: *Distribution patterns, *Ecological distribution, *Phytoplankton, *River systems, *Seasonal variation, Seasonal distribution, Temporal distribution, Bacteria, Estuarine environment, Tropical zones, Annual floods, Forests, Africa, *Isotope studies.

Four ecological zones of the Gambia River were sampled during four different hydrologic seasons for determination of microbial, nutrient, and physical parameters. A Greco-Latin Square experimental design was used to define the particular transect, station, depth, and tide/time-of-day of samples taken. Ranges of total bacterioplankton densities (1,000,000 ceils/ml) were similar to those of tropical and temperate environments. Numbers of free bacteria were similar temporally, whereas attached bacteria numbers were greater during periods of high stream flows when suspended solids concentrations were higher. Free bacteria were usually twice as numerous in the freshwater zones than in the estuarine zones. Attached bacterial densities were approximately four times greater in the estuarine zones than in the freshwater zones. Uptake of H-3-glucose on both a sample volume and per-cell basis increased from the early stages of the flood and reached observed annual maximums during the dry season. Spatially, H-3-glucose uptake per sample volume and per cell was highest in the upper river zone and lowest in the lower estuary zone. The lower estuary zone consistently acted out of concert with the other river zones in terms of H-3-glucose and C-14-bicarbonate uptake. Analysis of variance indicated that free and attached bacterioplankton densities were not homogeneous among transects, stations, depths, and tide/time-of-day at the different zones during the four hydrologic seasons. The results suggested that heterotrophy overshadowed autotrophy in the river and that the bacterial abundance, distribution, and glucose uptake activity in this tropical floodplain river were greatly influenced by the annual flood and the presence of extensive mangrove forests in the estuary. (Author's abstract)
W89-05079

EFFECTS OF TEMPERATURE ON MICROBIAL UTILIZATION OF LIGNOCELLULOSIC DETRITUS IN A THERMALLY IMPACTED SYSTEM,
Texas Univ. at Austin, Port Aransas. Marine Science Inst.
For primary bibliographic entry see Field 5C.
W89-05081

SIMPLE MODEL FOR FLOW ON HILLSLOPES,
New York State Coll. of Agriculture and Life Sciences, Ithaca. Dept. of Agricultural Engineering.
T. S. Steenhuis, J. Y. Parlange, M. B. Parlange, and F. G. Stagnitti.
Agricultural Water Management AWMADF, Vol. 14, No. 1-4, p 153-168, August 1988. 5 fig, 1 tab, 20 ref.

Descriptors: *Runoff, *Rainfall-runoff relationships, *Mathematical models, *Slopes, *Flow, *Hydrologic models, Finite difference methods, Drainage, Hydrology, Computer models, Climatic data.

A simple hillslope hydrological model predicting water movement on sloping shallow soils is developed. The simplified finite difference model has been demonstrated to be a good approximation of Richard's equation. Unlike existing hillslope models, the new model can be used to predict flow for long records of climatological data and it can be easily extended to include preferential flow. It compares favorably to other models with more restrictive input requirements, and has the potential for predicting preferential flow on non-homogeneous hillslopes. Its application is illustrated for experimental data collected for an homogeneous hillslope at the Cooweeta Hydrological Laboratory. (Author's abstract)
W89-05122

EMPIRICAL APPROACH FOR PREDICTING RUNOFF YIELD UNDER DESERT CONDITIONS,
Ben-Gurion Univ. of the Negev, Sde Boker (Israel). Jacob Blaustein Inst. for Desert Research.
A. Karnieli, J. Ben-Asher, A. Dodi, A. Issar, and G. Oron.
Agricultural Water Management AWMADF, Vol. 14, No. 1-4, p 243-252, August 1988. 6 fig, 2 tab, 16 ref.

Descriptors: *Model studies, *Runoff forecasting, *Runoff volume, *Rainfall-runoff relationships, *Deserts, Water harvesting, Arid lands, Mathematical models, Storm runoff, Statistical methods, Farming, Israel, Negev Desert.

An empirical model to predict runoff yield in the Negev desert (Israel) has been developed. The equation assumes a linear relationship between annual rainfall and runoff for a given watershed taking into account the reduction in runoff efficiency with an increase in catchment size. It uses the statistical parameters of the rain in order to calculate the recurrence interval of runoff yields. The results can be used to design and construct small catchments for runoff farming. Although the reduction function is based on measurements taken from a specific arid region in Israel, it may have a general form for many arid zones which are characterized by stony mountains without vegetation. The function could therefore be used as a first approximation when attempting to evaluate runoff volumes on an annual basis. Analysis of local rainfall records could be used to estimate availability of runoff for water harvesting projects in small desert basins. (Author's abstract)
W89-05130

ALLOCHTHONOUS DETRITUS INPUT TO A SMALL, COLD DESERT SPRING-STREAM,
Battelle Pacific Northwest Labs., Richland, WA. Geosciences Dept.
For primary bibliographic entry see Field 2H.
W89-05196

SERIAL DISCONTINUITY IN A LARGE RIVER SYSTEM,
Montana Univ., Polson. Flathead Lake Biological Station.
J. A. Stanford, F. R. Hauer, and J. V. Ward.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IV TLAP, Vol. 23, No. 2, p 1114-1118, August 1988. 3 fig, 1 tab, 6 ref.

Descriptors: *Ecological distribution, *Data collections, *Ecology, *River systems, *Temperature gradient, Flathead River, Canada, Montana, Rocky Mountains, Temperature, Hydropsychids, Ecosystems, Stream order, Serial discontinuity concept.

Abiotic (temperature) and biotic (relative abundance of hydropsychid Trichoptera) discontinuities exist serially within the Flathead River system (Canada and United States). These discontinuities occur as a result of natural (lakes and springs) and anthropogenic (epilimnial and hypolimnial release dams) stream regulation. A 20 year biophysical database at 15 sites was examined. Quantitative discontinuities were evident in the temperature data. Annual degree days increased in a downstream direction as a linear function of altitude or stream order. The distributions of the hydropsychids constitute serial discontinuities. Virtually any variable can be interpreted in terms of the Serial Discontinuity Concept in stream systems. Because riverine energy transfer processes result in predictable ecological discontinuities, it is suggested that the Serial Discontinuity Concept may serve as a quantitative approach toward a unifying theory of riverine energetics. Serial discontinuities may constitute the results of natural, replicated and ecosystem level experiments, which demonstrate energetic responses within ecological boundaries or ecotones as one moves from headwater to lower order environments. (Davis-PTT)
W89-05197

COMMUNITY DYNAMICS OF BACTERIA, ALGAE, AND INSECTS IN A FIRST ORDER STREAM IN NEW HAMPSHIRE, U.S.A.,
Michigan State Univ., East Lansing. Dept. of Zoology.
For primary bibliographic entry see Field 2H.
W89-05199

RESPONSES OF MACROINVERTEBRATES OF TWO HEADWATER STREAMS TO DISCHARGE FLUCTUATIONS,
Michigan Univ., Ann Arbor. School of Natural Resources.
F. F. Hooper, and D. R. Ottey.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IV TLAP, Vol. 23, No. 2, p 1159-1166, August 1988. 4 tab, 16 ref.

Descriptors: *Ecology, *Stream biota, *Stream gradient, *Flow discharge, Convict Creek, California, Hunt Creek, Thunder Bay River, Michigan, Light intensity, Drift, Stream discharge.

Experiments conducted in two streams with different gradients examine the relationship of drift rate to light intensity and discharge. Convict Creek is located on the eastern slope of the Sierra Nevada range in Mono County, California. The study area was a 340 m reach below a system of weirs and diversions used to regulate discharge in two experimental channels within the Sierra Nevada Aquatic Research Laboratory area. Hunt Creek is a second order tributary to the Thunder Bay River in Montmorency County, Michigan. The study area within the Hunt Creek Trout Research Station area was a 60 m reach of experimental channels below diversions permitting control of discharge. The two

streams differ greatly in physical and biological properties. Hunt Creek has extensive homogenous pebble beds dominated in summer by Baetis, Glossosoma, Simuliidae and Chironomidae. Faunal densities in these areas appear to be much larger than in the cobble boulder habitat of Convict. Daytime flow increases produced greater increases in drift rates in Hunt than in Convict but these, as well as flow reductions, generally had minor effects upon benthos densities. In both, however, declines in chironomid standing crops accompanied some regulated flow patterns. In Convict there were few daylight responses but at night there were large drift increases for a great variety of taxa. Greater stream bed heterogeneity and rapid currents in Convict may make active relocation via drift at both high and low flows more difficult than at Hunt. Late night discharges may represent opportunities for controlled drift relocation at a time when risk of visual predation is low. In high gradient streams such as Convict, faunal relocations from flow manipulations appear to have far greater impact at low light intensities than during daylight. (Davis-PTT)
W89-05202

DOWNSTREAM EFFECTS OF A LARGE, DEEP-RELEASE, HIGH MOUNTAIN RESERVOIR ON LOTIC ZOOBENTHOS,
Colorado State Univ., Fort Collins. Dept. of Zoology and Entomology.
For primary bibliographic entry see Field 2H.
W89-05203

EFFECTS OF WATERSHED VEGETATION AND DISTURBANCE ON INVERTEBRATE COMMUNITY STRUCTURE IN WESTERN CASCADE STREAMS: IMPLICATIONS FOR STREAM ECOSYSTEM THEORY,
Utah State Univ., Logan. Dept. of Fisheries and Wildlife.
For primary bibliographic entry see Field 2H.
W89-05204

DISTURBANCE AS A DETERMINANT OF STRUCTURE IN A SONORAN DESERT STREAM ECOSYSTEM,
Arizona State Univ., Tempe. Dept. of Zoology.
For primary bibliographic entry see Field 2H.
W89-05206

PRODUCTION OF SOLUBLE, HIGH MOLECULAR WEIGHT PHOSPHORUS AND ITS SUBSEQUENT UPTAKE BY STREAM DETRITUS,
Oak Ridge National Lab., TN. Environmental Sciences Div.
For primary bibliographic entry see Field 2H.
W89-05207

MICROBIAL ACTIVITY AND PHOSPHORUS UPTAKE ON DECOMPOSING LEAF DETRITUS IN A HETEROTROPHIC STREAM,
Oak Ridge National Lab., TN. Environmental Sciences Div.
For primary bibliographic entry see Field 2H.
W89-05208

STRUCTURE AND FUNCTION OF A BLACKWATER RIVER IN THE SOUTHEASTERN U.S.A.,
Alabama Univ., University. Aquatic Biology Program.
For primary bibliographic entry see Field 2H.
W89-05209

COMBINING OPEN CHANNEL FLOW AT RIGHT ANGLED JUNCTIONS,
Concordia Univ., Sir George Williams Campus, Montreal (Quebec).
For primary bibliographic entry see Field 8B.
W89-05212

BAR FORM RESISTANCE IN GRAVEL-BED RIVERS,
University of East Anglia, Norwich (England). School of Environmental Sciences.
For primary bibliographic entry see Field 8B.
W89-05215

DERIVED FREQUENCY DISTRIBUTION FOR STORM RUNOFF POLLUTION,
Old Dominion Univ., Norfolk, VA. Dept. of Civil Engineering.
A. O. Akan.
Journal of Environmental Engineering JOEDDU, Vol. 114, No. 6, p 1344-1351, December 1988. 3 fig, 6 ref.

Descriptors: *Urban runoff, *Storm runoff, *Suspended solids, *Frequency distribution, *Water pollution sources, *Statistics, Rainfall-runoff relationships, Nonpoint pollution sources, Mathematical models, Mathematical equations.

An analytically derived frequency distribution is reported to determine the probability of occurrence of solids washoff in different amounts form impervious urban areas. Also an expression is derived for the expectation of annual solids washoff. The resulting expressions contain several basin parameters related to land-use practices. These parameters can be obtained from local data on storm runoff quality associated with only a few storms. Detailed historical rainfall data is needed since the joint probability density function of rainfall depth and time period between two storms should be known to apply the proposed approach. The use of the derived frequency is illustrated by a sample application. (Author's abstract)
W89-05225

DYNAMICS OF THE FORESTED SHORELINE AND RECENT VARIATIONS IN THE LEVEL OF THE SAINT LAWRENCE RIVER (DYNAMIQUE D'UNE BORDURE FORESTIERE ET VARIATIONS RECENTES DU NIVEAU DU FLEUVE SAINT-LAURENT),
Laval Univ., Quebec. Centre d'Etudes Nordiques.
Y. Begin, and J. Lavoie.
Canadian Journal of Botany CJBOAW, Vol. 66, No. 10, p 1905-1913, October 1988. 7 fig, 47 ref.

Descriptors: *Flooding, *Floods, *Saint Lawrence River, *Riparian vegetation, *Succession, *Estuaries, *Geomorphology, *Rising stage, Canada, Shores, Historic floods, Ecological effects.

The forested shoreline of the Saint Lawrence River upper estuary is frequently damaged by spring ice, currents, and waves during episodes of high water levels. A dendroecological analysis of the significant river floods, as recorded by ring-width patterns of uprooted woody plants, population growth and decay structures, and scars caused by ice on trees within the shore environment, provides direct evidence of a landward migrating shoreline. Regressive succession of vegetation is associated with a general rise in year-to-year flood levels. Plant community dynamics and shore sediment migration were investigated in a particularly exposed site between Grondines and Sainte-Anne-de-la-Perade. Most of the oldest sublittoral trees are undergoing slow degradation and hydrophilous shrubby stands show extensive expansion within the shoreline habitat, which is associated with an important landward displacement of sediments. These ecological and geomorphological results concur with the general rising trend of flood levels of the Saint Lawrence during the last 30 years. (Author's abstract)
W89-05254

POPULATION STRUCTURE OF STREAM-DWELLING DARTERS: CORRESPONDENCE WITH HABITAT STRUCTURE,
University of Southern Mississippi, Hattiesburg. Dept. of Biological Sciences.
For primary bibliographic entry see Field 2H.
W89-05261

EFFECTS OF SPATIAL ORIENTATION OF MULTIPLE PLATE ARTIFICIAL SUBSTRATES ON INVERTEBRATE COLONIZATION,
Geological Survey, Menlo Park, CA. Water Resources Div.
For primary bibliographic entry see Field 7B.
W89-05268

HYDROLOGIC MODELING USING A SIMULATION LANGUAGE BASED ON QUEUEING THEORY,
Agricultural Research Service, Temple, TX. Grassland, Soil and Water Research Lab.
For primary bibliographic entry see Field 7C.
W89-05277

ALKALINITY DYNAMICS IN A HARD-WATER PRAIRIE-MARGIN STREAM,
Oak Ridge National Lab., TN.
A. J. Stewart.
Archiv fuer Hydrobiologie AHYBA4, Vol. 112, No. 3, p 335-350, May 1988. 5 fig, 2 tab, 29 ref. NSF Grant BSR-8307014, DOE Contract DE-AC05-840R21400.

Descriptors: *Water chemistry, *Hardness, *Prairies, *Carbonates, *Seasonal variations, *Water temperature, *Alkalinity, Heavy metals, Calcium, Magnesium, Sodium, Hydrogen ion concentration, Water cycle, Floods, Gravel, Phosphates.

Seasonal increases in water temperature are important in governing the conversion of soluble alkalinity into particulate carbonates in Brie Creek, a small hard-water stream in south-central Oklahoma. Alkalinity was diluted episodically by floods ten times during the six-month study. During floods, the ratio of calcium to magnesium dropped from about 12 to 10 and the concentrations of calcium, magnesium and sodium fell by 35 and 50%. After each flood, pre-flood chemical conditions were restored rapidly (typically within 4-6 days). Alkalinity values not affected by flood events declined more or less uniformly by more than 44% from mid-April (4.68 meq/L) to early September (2.60 meq/L). Maximum daily water temperature during the period of alkalinity loss was inversely related (r squared = 0.83; n = 68) to alkalinity when flood-related dilution events were excluded from the analysis. Alkalinity declined most rapidly (up to 0.096 meq/L-day) when minimum daily water temperature exceeded 27 C. From early July through early September, no rain fell and minimum water temperature exceeded 25 C. During this period, concentrations of sodium and magnesium increased (by 50 and 26%, respectively) due to evaporation, but the concentration of calcium (and the ratio of calcium to magnesium) declined, indicating a selective precipitation of CaCO3. Calcite scums formed on pools during periods of hot weather. Surface scums concentrated by wind had more than 40 meq/sq m of alkalinity (as CaCO3), but contained > 1% of the alkalinity in the water. Laboratory experiments showed that (1) gravel promoted loss of alkalinity from stream water as a non-linear function of water temperature (loss rates increased rapidly above 25 C); (2) loss of phosphate added to stream water was more rapid at 40 C than at 15 C in the presence of gravel and was negligible at 40 C and 15 C when gravel was present; and (3) creek gravel and phosphate interactively influence pH, alkalinity, and conductivity of unfiltered creek water in 24-h incubations at 35 C. Temperature-driven shifts in soluble vs. particulate phases of carbonates can be expected to affect the cycling patterns of phosphorus, because particulate carbonates are efficient scavengers of phosphorus. (Author's abstract)
W89-05281

INFLUENCE OF THE ENVIRONMENT ON WILLOW LEAF LITTER DECOMPOSITION IN THE ALLUVIAL CORRIDOR OF THE GARRONE RIVER,
Centre National de la Recherche Scientifique, Toulouse (France). Centre d'Ecologie des Ressources Renouvelables.
For primary bibliographic entry see Field 2H.
W89-05283

IMPACT OF NUTRIENT INPUT FROM THE RIVER SEINE ON PHYTOPLANKTON POPULATIONS IN A SAND-PIT LAKE (BIGNAN, NW FRANCE),
Ecole Normale Superieure, Paris (France). Lab. d'Ecologie.
For primary bibliographic entry see Field 5C.
W89-05291

COLONIZATION OF LEAF LITTER BY AQUATIC HYPHOMYCETES IN A TROPICAL STREAM,
Mangalore Univ. (India). Dept. of Biosciences.
For primary bibliographic entry see Field 2H.
W89-05293

BENTHIC FAUNA OF ETHIOPIAN MOUNTAIN STREAMS AND RIVERS,
Waterloo Univ. (Ontario). Dept. of Biology.
For primary bibliographic entry see Field 2H.
W89-05294

TRANSPORT OF PHOSPHORUS, NITROGEN, AND CARBON BY THE APURE RIVER, VENEZUELA,
Colorado Univ. at Boulder. Dept. of Environmental, Population, and Organismic Biology.
For primary bibliographic entry see Field 2H.
W89-05324

DIFFERENTIATION OF SOME VENEZUELAN BLACKWATER RIVERS BASED UPON PHYSICO-CHEMICAL PROPERTIES OF THEIR HUMIC SUBSTANCES,
Instituto Venezolano de Investigaciones Cientificas, Caracas. Centro de Ecologia y Ciencias Ambientales.
T. Vegas-Vilarrubia, J. E. Paolini, and J. Garcia Miragaya.
Biogeochemistry, Vol. 6, No. 1, p 59-77, 1988. 8 fig, 4 tab 60 ref. Gran Mariscal Ayacucho Foundation Grant F-Na-830657, Venezuelan Research Council Grant DDCT-PIMA 20.

Descriptors: *Humic acids, *Venezuela, *Tropical regions, *Water analysis, *Water chemistry, *Biogeochemistry, Physicochemical properties, Ecosystems, Watersheds, Rain forests, Hydrological regime, Separation techniques, Gel chromatography, Infrared spectrophotometry, Fluorometry.

The dissolved humic substances of seven Venezuelan blackwater rivers, belonging to different tropical biogeographical regions, were analyzed. Fractionation using Sephadex gel together with an analysis of their fluorescence, absorbance and infrared spectral properties, showed differences between their humic substances. These differences were related to their biological sources and humification environment. Statistical analysis of the properties of these humic substances allowed separation of the rivers into three groups. These groups were directly related to the geological features and vegetation of the terrestrial ecosystems into which they drain: (1) the Autana, Atabapo, Chola, Negro which belong to the Amazon basin on the Guyana Shield, each with typical blackwater riverine forest; (2) The Caroni, belonging to the Orinoco basin on the Guayana Shield and with tropical humid forest and rainforest; (3) the Morichal Largo, which drains the Mesa Formation from the eastern Llanos and has gallery forest of Mauritia flexuosa. (Author's abstract)
W89-05326

ASSOCIATIONS BETWEEN STREAM VALLEY GEOMORPHOLOGY AND RIPARIAN VEGETATION AS A BASIS FOR LANDSCAPE ANALYSIS IN THE EASTERN SIERRA NEVADA, CALIFORNIA, USA,
Oregon State Univ., Corvallis. Dept. of Forest Science.
For primary bibliographic entry see Field 2J.
W89-05340

WATER RESOURCES OF THE PARK CITY AREA, UTAH WITH EMPHASIS ON GROUND WATER,
Geological Survey, Austin, TX. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-05405

WATER RESOURCES OF THE APOSTLE ISLANDS NATIONAL LAKESHORE, NORTHERN WISCONSIN,
Geological Survey, Madison, WI. Water Resources Div.
W. J. Rose.
Water-Resources Investigations Report 87-4220, 1988. 44p, 30 fig, 23 tab, 19 ref.

Descriptors: *Water resources, *Apostle Islands National Lakeshore, *Lake Superior, *Hydrologic data collections, Water quality, Wisconsin, Streamflow, Mercury, Phosphorus, Organic carbon, Pesticides, Bacteria, Groundwater budget.

The Apostle Islands National Lakeshore consists of 21 islands, part of the Bayfield Peninsula, and the adjacent waters of Lake Superior. Selected water resources of the Apostle Islands National Lakeshore were assessed to aid the National Park Service in developing and managing the Lakeshore and to provide a data base against which future changes can be compared. This summary of water resources data, collected by the U.S. Geological Survey during 1979-84, provides a qualitative description of the following selected hydrologic components of the Lakeshore: streamflow, chemical concentrations, sediment load, runoff, acidity, evaporation, water quality (coliforms, phosphorus, organic carbon, mercury, pesticides, bacteria), water pollution effects, and groundwater use. (Lantz-PTT)
W89-05408

SEEPAGE STUDIES OF THE WEBER RIVER AND THE DAVIS-WEBER AND OGDEN VALLEY CANALS, DAVIS AND WEBER COUNTIES, UTAH, 1985,
Geological Survey, Salt Lake City, UT. Water Resources Div.
L. R. Herbert, R. W. Cruff, D. W. Clark, and C. Avery.
Utah Department of Natural Resources Technical Publication No. 90, 1987. 53p, 9 fig, 4 tab, 2 ref.

Descriptors: *Surface-groundwater relations, *Hydrologic data collections, *Seepage, *Weber River, *Davis-Weber Canal, *Ogden Valley Canal, *Water loss, Utah, River flow, Rivers, Water level fluctuations.

Studies of selected reaches of the Weber River, Davis-Weber Canal, and the Ogden Valley Canal in Davis and Weber Counties, Utah, were made to determine gains or losses of flow in those reaches. Three to five sets of seepage measurements were made on the river and each canal during 1985. Adjustments for fluctuations in flow were made from information obtained from water-stage recorders operated at selected locations during the time of each set of seepage measurements. The studies indicated a loss of 20.0 cu ft/sec in the upstream reach of the Weber River and a gain of 17.0 cu ft/sec in the downstream reaches or a net loss of 3.0 cu ft/sec. Study results also indicated a net loss of 17.0 cu ft/sec in the Davis-Weber Canal and a net loss of 4.0 cu ft/sec in the Ogden Valley Canal. (Author's abstract)
W89-05410

WATER IN THE HORSE HEAVEN HILLS, SOUTH-CENTRAL WASHINGTON,
Geological Survey, Tacoma, WA. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-05421

FLOODS OF OCTOBER 1986 IN SOUTHCENTRAL ALASKA,
Geological Survey, Anchorage, AK. Water Resources Div.
R. D. Lamke, and B. B. Bigelow.
Open-File Report 87-391, 1988. 31p, 11 fig, 5 tab, 8 ref.

Descriptors: *Storm runoff, *Floods, *Alaska, Precipitation, Flood damage, Flood stages, Flood profiles, Hydrologic data, Disasters.

Heavy precipitation associated with a large storm system resulted in major flooding in several areas of southcentral Alaska during October 10-12, 1986. Flooding was particularly severe in the Seward area of the Kenai Peninsula and in tributaries to Susitna River from Talkeetna downstream. Flood damage has been estimated at $20 million and the region was declared a Federal disaster area. The report includes a brief discussion of meteorological conditions that caused the unusual amounts of precipitation, a summary of flood stages and discharges, a comparison to prior floods, flood-frequency estimates, a brief description of flood areas, and hydrologic data for each area. (Author's abstract)
W89-05425

RUHENGERI WATER RESOURCES STUDY RWANDA,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
P. Roark, and B. H. Dickson.
Water and Sanitation for Health Project, Washington, DC. WASH Field Report No. 181, May 1986. 127p, 9 fig, 17 tab, 5 append. AID Contract 5942-C-00-4085-00, Project 936-5942.

Descriptors: *Groundwater, *Surface Water, *Developing countries, *Rivanda, *Water resources management, *Water resources development, *Hydrologic budget, *Water supply development, Potable water, Marshes, Precipitation, Arsenic, Water pollution sources, Forest watersheds, Springs, Catchment basins.

As part of the Ruhengeri Resources Analysis and Management (RRAM) Project, a water resources analysis was undertaken by a two-person team from March 10 to April 4, 1986. The Ruhengeri Prefecture consists of several distinct environments, each of which is characterized by a unique set of hydrologic variables. While average hydrologic conditions have been established, the annual variations have been found to be large. For this reason, a modest extension of the hydrologic and meteorological network is recommended. The Rugezi Marsh is a fragile environment which, from a hydrologic perspective, will require a complex water control system if it is to be developed for agricultural purposes. Arsenic, from tungsten mining, has been found in high concentrations in sediment samples, but not water samples. Montane forests within the national park lands have important hydrologic value in buffering torrential stream flow and in reducing erosion losses. Any degradation of these forests can be predicted to influence crop production negatively on the valuable lands in the Lava Zone. The most widespread and most suitable technology for domestic water supply is springs, with or without piped delivery systems, where they are available. Rainwater catchment is a promising technology, but the storage cisterns that are required are too expensive for widespread adoption by the general public. However, rainwater catchment system for the people living in the Lava Zone would cost only one quarter as much as the proposed World Bank system, and even these costs could be reduced appreciably if less costly storage cisterns could be developed. (Lantz-PTT)
W89-05527

VEGETATION OF INLAND WATERS.
For primary bibliographic entry see Field 2H.
W89-05543

ANALYSIS OF FLORA AND VEGETATION IN RIVERS: CONCEPTS AND APPLICATIONS,
Oldenburg Univ. (Germany, F.R.). Dept. of Biology.
G. Wiegleb.
IN: Vegetation of Inland Waters. Kluwer Academic Publishers, Boston, MA. Handbook of Vegetation Science Series Vol. 15/1. 1988. p 311-340, 3 tab, 103 ref.

Descriptors: *Aquatic vegetation, *Vegetation, *Flora, *Aquatic plants, *Plant populations, Rivers, Streams, Distribution, Aquatic weeds, Nutrients, Macrophytes, Water currents, Europe, Japan.

Macrophytes are important in river systems as primary producers and as food and habitat for macrofauna. In addition, they influence the water chemistry, and they have a physical effect on the environment. A successful classification of rivers requires an evaluation of the importance of factors actually influencing the occurrence of macrophytes. These factors, which include the hydrological regime, current velocity, calcium hydrogen carbonate complex, nutrients like N and P, and anthropogenic influence, are discussed with special consideration of European and Japanese river habitats. At least three complexes of geographical variation can be observed in aquatic communities as well as in terrestrial ones: (1) climatic variance, (2) geological variance, (3) geomorphological variance. When referring to mosaic habitats the development of vegetation does not follow regular patterns and is not in direct accordance with the present measurable habitat parameters. However, if the life histories of the species involved are sufficiently known and the constraints of habitat parameters are exactly defined, the testing of hypotheses should be possible. (See also W89-05543) (White-Reimer-PTT)
W89-05553

INVESTIGATION OF THE POSSIBLE FORMATION OF DIETHYLNITROSAMINE RESULTING FROM THE USE OF RHODAMINE WT DYE AS A TRACER IN RIVER WATERS,
For primary bibliographic entry see Field 5B.
W89-05589

ESTIMATING STREAM-AQUIFER INTERACTIONS IN COAL AREAS OF EASTERN KANSAS BY USING STREAMFLOW RECORDS,
H. E. Bevans.
IN: Selected Papers in the Hydrologic Sciences 1986. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Supply Paper 2290. 1986. p 51-64, 8 1 fig, 1 tab, 9 ref.

Descriptors: *Acid mine drainage, *Water pollution sources, *Path of pollutants, *Model studies, *Surface-groundwater relations, *Kansas, *Mine drainage, Coal mines, Hydrologic models, Aquifer characteristics, Groundwater recharge, Transmissivity, Mathematical equations.

Stream-aquifer interactions for drainage basins in coal areas of eastern Kansas were estimated for streamflow records and are presented as an alternative or supplement to digital modeling. Streams draining coal-mined parts of this area usually are contaminated during low flow by groundwater containing large concentrations of sulfate discharged from the mines. The capacity of a stream to assimilated the coal-mine drainage is governed by the availability of base flow for dilution. Although digital models for simulating interactions between streams and aquifers are available, representative values of aquifer properties necessary to calibrate the models commonly are unavailable and are expensive to obtain. Values of the stream-aquifer property T/a squared S (where T is the transmissivity of the aquifer, a is the average distance from the stream to the groundwater divide in feet, and S is the storage coefficient of the aquifer) ranging from 0.012 to 0.049/day were determined from the slopes of base flow regression curves recorded at 18 selected streamflow-gaging stations. Correlation and regression analysis was used to develop an equation for predicting T/a squared S for ungaged streams in the study area, as follows: T/a squared S = 0.050 - 0.0133 log DA (where DA is the drainage area in square miles). The correlation coefficient of this relationship is -0.99, and the standard error of the estimate is 0.001 per day. Examples of procedures for estimating groundwater storage, recharge, discharge, and evapotranspiration using streamflow records and T/a squared S values are presented. (See also W89-05586) (Author's abstract)
W89-05590

RECENT GROWTH OF GULKANA GLACIER, ALASKA RANGE, AND ITS RELATION TO GLACIER-FED RIVER RUNOFF,
For primary bibliographic entry see Field 2C.
W89-05593

EXTENSION OF THE UNSTEADY ONE-DIMENSIONAL OPEN-CHANNEL FLOW EQUATIONS FOR FLOW SIMULATION IN MEANDERING CHANNELS WITH FLOOD PLAINS,
L. L. DeLong.
IN: Selected Papers in the Hydrologic Sciences 1986. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Supply Paper 2290. 1986. p 101-105, 6 fig, 8 ref.

Descriptors: *Open-channel flow, *Mathematical equations, *Meander belt, *Channel morphology, *Model studies, *Flood plains, Simulation, Mathematical studies, Flood peak, Flood hydrographs, Performance evaluation, Numerical analysis, Traveltime, Rivers, Mathematical models.

Simulation of unsteady flow in natural rivers is complicated by significant variation in hydraulic properties as a meandering river inundates a flood plain. The unsteady one-dimensional open-channel flow equations are generalized to include variation in channel length with depth of flow. Hydraulic properties of complex channel cross sections are represented through variation of momentum coefficients and conveyance with depth of flow. Flood peaks were numerically routed through hypothetical rivers with and without meanders, and downstream hydrographs were compared at equivalent main-channel distance. The flood-plain inundation during high flow reduced effective channel length of the meandering river and resulted in nearly a one-third reduction in flood-peak travel time. The governing equations were solved by using an orthogonal-collocation, finite-element method, formulated in terms of cross-sectional area and discharge. Although the main channel and flood plain are treated as a continuous cross-sectional area, top width does not appear directly in the governing equations or numerical computations. Consequently, the sudden expansion in top width as flow spills onto the flood plain does not cause numerical failure in this method as it commonly does in other methods formulated in terms of depth of flow or stage, top width, or discharge. (See also W89-05586) (Author's abstract)
W89-05594

COMPARISON OF TWO STREAM-DISCHARGE RECORD RECONSTRUCTION TECHNIQUES FOR EIGHT GAGING STATIONS IN MAINE,
R. A. Fontaine.
IN: Selected Papers in the Hydrologic Sciences 1986. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Supply Paper 2290. 1986. p 107-111, 1 fig, 4 tab, 1 ref.

Descriptors: *Stage-discharge relations, *Stream gaging, *Data acquisition, *Discharge measurement, *Discharge record reconstruction, Maine, Standard error, Estimating, Performance evaluation.

An analysis of two commonly used stream-discharge record-reconstruction methods shows that the standard error of estimate from a missing record can be improved by using independent observations of stage. The accuracy of a missing record reconstructed by using both techniques was evaluated at eight stream gages in Maine where independent observations of stage and correlative stream gage data from other sites were available. The average standard error for a missing record reconstructed with flow data from other stream gages is 52.9%. The average standard error for a missing record reconstructed with independent observations of stage at the same site was 15.0%. The average standard error of published streamflow data in Maine is currently 17.7%. This average standard error could be reduced to approx 13.0% if independent observations of stage were available to estimate the missing record. (See also W89-05586) (Author's abstract)
W89-05595

CHANNEL WIDENING CHARACTERISTICS AND BANK SLOPE DEVELOPMENT ALONG A REACH OF CANE CREEK, WEST TENNESSEE,
For primary bibliographic entry see Field 2J.
W89-05596

COMPARISON OF VELOCITY INTERPOLATION METHODS FOR COMPUTING OPEN-CHANNEL DISCHARGE,
For primary bibliographic entry see Field 7B.
W89-05598

PRELIMINARY EVALUATION OF A DISCHARGE COMPUTATION TECHNIQUE THAT USES A SMALL NUMBER OF VELOCITY OBSERVATIONS,
L. R. Bohman, and W. J. Carswell.
IN: Selected Papers in the Hydrologic Sciences 1986. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Supply Paper 2290. 1986. p 145-154, 6 fig, 3 tab, 4 ref.

Descriptors: *Gaging, *Standards, *Velocity distribution, *Open-channel flow, *Discharge measurement, Large rivers, Mathematical equations, Estimating, Interpolation.

A study was made of a discharge measurement technique for unsteady flow being considered by the International Organization for Standardization. The new technique uses a small number of velocity observations and a measured channel cross section to develop a lateral velocity distribution. The technique was tested using 3, 5, and 7 vertical velocity observations from 25 discharge measurements at five streamflow gaging stations. An average bias of about +2.5% indicates that discharge may be overestimated by the new procedure when compared to the standard midsection method. Percent differences ranged from +28.5 to -38.3 and decreased as either the number of velocity observations or discharge increased. A large part of the difference was probably a result of channel-bottom irregularities, pier influence, and extrapolation necessary between the last velocity observation and the bank. It was determined that the location of velocity observations probably could be optimized to improve the accuracy of the method. The results of this study indicate that further investigation of the technique and its potential as a discharge measurement tool for steady or unsteady flow at large rivers with uniform flow in the vicinity of the measurement section is warranted. (See also W89-05586) (Author's abstract)
W89-05599

REGIONAL FLOOD FREQUENCY ANALYSIS: PROCEEDINGS OF THE INTERNATIONAL SYMPOSIUM ON FLOOD FREQUENCY AND RISK ANALYSES, 14-17 MAY 1986, LOUISIANA STATE UNIVERSITY, BATON ROUGE, U.S.A.
D. Reidel Publishing Company, Boston, MA. 1987. 400p. Edited by Vijay P. Singh.

Descriptors: *Regional analysis, *Symposium, *Risk assessment, *Frequency analysis, *Flood frequency, *Parametric hydrology, Risks, Flood forecasting, Statistical analysis, Model studies, Research priorities.

Floods constitute a persistent and serious problem throughout the United States and many other parts of the world. A symposium was held where people from all over the world could assemble, discuss and share their experience and expertise pertaining to flood frequency and risk analyses. The objectives of this symposium were: to assess the current state of the art of flood frequency and risk analyses, to demonstrate the applicability of flood fre-

quency and risk models, to establish complementary aspects of seemingly different models, to enhance interdisciplinary interaction, to discuss the practice of flood frequency and risk analyses technology by federal agencies in the United States, to discuss research needs in frequency and risk analyses, and to determine directions for further research. (See W89-05615 thru W89-05641) (Author's abstract)
W89-05614

REGIONAL ANALYSIS OF FLOOD FREQUENCIES,
Geological Survey, Reston, VA.
G. D. Tasker.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 1-9, 34 ref.

Descriptors: *Regional analysis, *Regression analysis, *Flood frequency, *Statistical analysis, Flood forecasting, Probability distribution, Regression analysis, Mathematical studies, Estimating, Correlation analysis.

Recent advances in the index flood method and regional regression method of regional flood frequency analysis are summarized. Wallis and others have developed a new index flood method which uses probability weighted moments and have shown it to be a viable means of improving at-site flood frequency estimates. Stedinger and others have developed and tested a means of accounting for unequal record length and cross correlation in a regional regression. They have shown that these methods can improve estimates of flood frequency at ungaged sites. (See also W89-05614) (Author's abstract)
W89-05615

REGIONAL FLOOD DISCHARGE ANALYSIS SOUTHWEST REGION OF THE KINGDOM OF SAUDI ARABIA,
King Abdulaziz Univ., Jeddah (Saudi Arabia). Dept. of Hydrogeology.
A. U. Sorman, and M. J. Abdulrazzak.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 11-25, 1 fig, 8 tab, 10 ref.

Descriptors: *Regional analysis, *Flood frequency, *Statistical analysis, *Flood discharge, *Saudia Arabia, Flood forecasting, Mathematical studies, Wadi, Probability distribution, Flood recurrence interval, Correlation analysis.

A regional analysis of flood characteristics for the wadis of the southwestern region of Saudia Arabia which drains towards the Red Sea is presented. Nine gauged wadis are selected and their flood discharge parameters are determined. Pearson type III and Extreme type I distributions are the best representative probability distributions. The flood magnitudes with various recurrence intervals are estimated using both distribution functions. The ratios of estimated peak floods for various recurrences are computed to derive the regional frequency values for each of the subregions. The two year annual flood discharges are statistically correlated with hydrologic, morphometric and soil data parameters so that the maximum flood discharges can be estimated for ungauged wadis with similar climatic and hydrologic conditions. The area, mean annual rainfall, infiltration area, relative relief, and mean effective hydraulic conductivity values are the most significant parameters affecting the annual two year flood discharges. (See also W89-05614) (Author's abstract)
W89-05616

REGIONAL FLOOD FREQUENCY ANALYSIS FOR SOME SELECTED BASINS IN SAUDI ARABIA,
King Saud Univ., Riyadh (Saudi Arabia). Dept. of Civil Engineering.
A. S. Al-Turbak, and A. A. Quraishi.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 27-34, 4 tab, 3 ref.

Descriptors: *Regional analysis, *Peak flow, *Saudi Arabia, *Flood frequency, *Statistical analysis, Flood forecasting, Wadi, Probability distribution, Computer programs, Regression analysis, Drainage area.

Annual peak flow rates from 13 runoff gaging stations in Saudi Arabia are considered. These stations are located in two different regions of the south-western part of the Kingdom. Seven stations are within Wadi Bishah drainage area while six are in Tihamah-South region. The 5, 10, 25, 50, and 100 years floods values were calculated for the 13 stations using both the Extreme Value Type I (EVI) and the Log Pearson Type III (LP3) distributions. Results showed EVI to give better estimates than LP3. Therefore, the EVI values were the only ones used in the rest of the study. The obtained results (EVI) were then used to check for homogeneity for all the stations within each area. A regional flood frequency analysis was performed. Multiple regression equations relating peak flow rates in each area to four watershed and precipitation variables were established. These independent variables are: drainage area, mean annual precipitation, main channel length and average main channel slope. Using a computer program, regression coefficients for all the equations were obtained and checked. The resulting equations will be important tools for design as well as other studies related to surface water in these two developing regions of the Kingdom. (See also W89-05614) (Author's abstract)
W89-05617

HIERARCHICAL APPROACH FOR REGIONAL FLOOD FREQUENCY ANALYSIS,
Universita di Reggio Calabria, Cosenza (Italy). Dipt. di Difesa del Suolo.
M. Fiorentino, S. Gabriele, F. Rossi, and P. Versace.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 35-49, 2 fig, 3 tab, 15 ref.

Descriptors: *Regional analysis, *Flood frequency, *Statistical analysis, Flood forecasting, Probability distribution, Italy, Flood data, Regression analysis, Variability, Simulation analysis.

In this paper a hierarchical approach for regional flood-frequency analysis is proposed. It is characterized by three investigation levels: (i) identification of homogeneous regions wherein the skewness coefficient is assumed not to vary from site to site; (ii) identification of homogeneous subregions wherein the coefficient of variation is assumed to be constant too; and (iii) use of regression models to relate a location parameter of the flood distribution to climatic and physiographic factors. The hierarchical approach is herein presented with the use of the two-component extreme value (TCEV) distribution. The validity of the presented approach is demonstrated using twenty-eight Italian annual flood series (AFS). In particular, it is shown that the sample skewness coefficient exhibits an observed variability comparable with the theoretical sampling variability, the latter derived by computer simulation experiments from a regionalized TCEV distribution considered as representative of the entire region in question. Instead, for the same AFSs, the observed variance of the coefficient of variation is nearly twice the one derived from the sampling experiments. (See also W89-05614) (Author's abstract)
W89-05618

APPLICATION OF REGIONAL FLOOD FREQUENCY ANALYSIS TO PHILIPPINE RIVERS,
Development of Environmental Systems, Inc., Quezon City (Philippines).
E. S. Salvo.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 51-66, 7 fig, 4 tab, 12 ref.

Descriptors: *Regional analysis, *Rivers, *Flood frequency, *Philippines, *Statistical analysis, Mathematical models, Probability distribution, Flood forecasting, Gaging stations, Annual floods, Flood recurrence interval.

The Philippines is divided into 12 water resources regions. Two regions, one in the Visayas and one in Mindanao were analyzed. After annual peaks within a region were listed and missing data filled in by correlation, preliminary frequency curves were prepared for each station using the log Person Type III distribution. Using the preliminary frequency curves, the homogeneity test was applied on all rivers within a region. For each region, a regional flood frequency curve was derived using the ratio of discharge to the mean annual flood as ordinate and recurrence interval as abscissa. Another curve was prepared showing the relation of mean annual flood to the size of the area. The equation $Qm = CA$ raised to the 0.77 power -- where Qm = mean annual flood in cubic m/s, A = watershed area in sq km, and C is a constant -- was derived. Regional flood frequency analysis can be applied without any doubt to increase the statistical quality of the regional frequency curve especially to a data-sparse country. In ungaged rivers within the region analyzed, the water resources engineer can use the Survey method of analysis. Although there are approximately 200 stream gaging stations and 369 rain gaging stations all over the country, only 87 of the stream gaging stations and 86 rain gages have more than 20 years of record. It is necessary that all regions be analyzed and regional frequency curves derived. A generalized skew coefficient applicable to the country should be derived and utilized in order to minimize bias in estimating future frequencies. Many years have elapsed since the Philippine Water Resources Summary Data was published in 1980. It is hoped that this study will serve its purpose until additional data that accumulated through the years will be published. (See also W89-05614) (Davis-PTT)
W89-05619

IMPROVING FLOOD QUANTILE ESTIMATION ON UNGAGED WATERSHEDS,
Wisconsin Univ., Madison. Dept. of Civil and Environmental Engineering.
E. P. Baldwin, and K. W. Potter.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 67-75, 3 fig, 1 tab, 3 ref.

Descriptors: *Ungaged watersheds, *Flood frequency, *Statistical analysis, Probability distribution, Mathematical studies, Wisconsin, Kickapoo River, Pecatonica River, Gaging stations, Regression analysis, Regional analysis, Estimating.

For many situations regional regression is the best available method for estimating flood quantiles at ungaged sites. However, the standard errors of existing regression equations can be uncomfortably large. Preliminary attempts to reduce these errors for drainage basins in the Driftless Area of Wisconsin are presented. The overall strategy is to investigate gaged rivers for which quantiles estimated from the observed flood series differ significantly from those predicted by the available regression equations. The Kickapoo and Pecatonica Rivers are gaged at multiple locations. The variation in quantiles at these gages is considerably smaller than would be expected from the variation in drainage area. The regional regression equations perform poorly, underestimating at the gages with the smallest areas and overestimating at the gages

with the largest areas. It was suspected that the timing of tributary contributions is responsible for the anomolous quantile relationships. This was confirmed by time-area histograms which were constructed for each gage. The peaks of the time area histograms appear to be useful for estimating flood quantiles at sites upstream or downstream of existing gages. Further work is needed to explore the value of this approach. (See also W89-05614) (Author's abstract)
W89-05620

REGIONAL PEAK FLOW STUDY IN SOUTHERN BRITISH COLUMBIA, CANADA,
Ministry of Forests and Lands, Kamloops (British Columbia).
J. D. Cheng, and D. E. Reksten.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 77-90, 6 fig, 2 tab, 15 ref.

Descriptors: *Regional analysis, *Maximum flow, *Peak flow, *Flood frequency, *Statistical analysis, *British Columbia, Probability distribution, Hydraulic structures, Rainfall, Gaging stations, Precipitation rate, Canada, Hydraulic desing, Snowmelt, Meteorological data collection.

To provide assistance in estimating peak flows for hydraulic structure design associated with road development, drainage and flood control works, this study was undertaken in two areas in southern British Columbia with different peak flow generation mechanisms. The two study areas are: the Lower Fraser Valley in southwestern B. C. near Vancouver where prolonged storms with high rainfall amounts are the major factor in causing annual peak flows; and the South Thompson Basin in south central B. C. near Kamloops where snowmelt is the dominant cause of annual peak flows. A mean annual daily peak flow map was first developed for both areas using peak flow data from gaged watersheds, topographic characteristics plus regionalized mean annual maximum 24 hour precipitation data for the Lower Fraser Valley and regionalized mean annual precipitation data for the South Thompson Basin. The regional frequency curves relating return period peak flows to mean annual daily peak flows were determined for identified subregions within each study area. The regionalized precipitation frequency data were derived from results of earlier studies using available climatic station records and a precipitation model based on orographic and frictionally induced vertical moisture flux parameters. Because the results reflect only the regional hydrologic conditions, they should not be used to calculate peak flows for streams outside the study regions. (See also W89-05614) (Author's abstract)
W89-05621

REGIONAL TREATMENT OF FLOOD DATA,
National Technical Univ., Athens (Greece). Dept. of Civil Engineering.
M. Mimikou.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 91-101, 3 fig, 2 tab, 7 ref.

Descriptors: *Regional analysis, *Flood data, *Flood frequency, *Statistical analysis, Greece, Mathematical studies, Flood forecasting, Flood flow, Climatic data, Gages, Discharge measurement, Drainage area.

The maximum observed peak discharges in stations of the northwestern and western regions of Greece are plotted against drainage areas and are found to be power functions of these drainage areas. The curves enveloping the plotted points are regionally varying according to the climatic regime. For relatively small basin sizes, the flood runoff rates per unit area of the two regions can be reasonably assumed to become equal. When the peak discharges are plotted against a morphoclimatic index, which is the product of the expected storm duration by the maximum observed average storm intensity for this duration by the area of the drainage basin, a single linear envelope curve is drawn for both regions that explains 95 percent of the regional variation in the dependent variable. The envelope curves may give evidence as to the flood magnitude to be expected from ungaged basins of the area, with a return period at least equal to the return period of the analyzed flood data. The use of a cookbook method can give information for even less frequent flood flows. The developed envelope curves can predict peak discharges at certain probability levels for ungaged basins of the area and can be used in specific engineering applications like the hydrologic design of diversion works and spillways. (See also W89-05614) (Author's abstract)
W89-05622

STATISTICAL ANALYSIS OF FLOODS AND REGIONAL RELATIONS,
Politechnika Warszawska (Poland). Inst. of Environmental Engineering.
M. Ozga-Zielinska.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 103-118, 3 fig, 1 tab, 14 ref.

Descriptors: *Regional analysis, *Floods, *Flood frequency, *Statistical analysis, Flood forecasting, Mathematical studies, Probability distribution, Flood data, Discharge hydrographs, Flood hydrographs, Multivariate analysis.

Several basic issues and problems pertaining to the use of mathematical statistics for flood analysis, including development of regional relations used in many countries for estimation of specific flood events, are discussed. The following issues and problems are discussed: maximum discharges and floods, nonhomogeneity of the observation series, flood as a multivariate phenomenon, probability in a set vs. annual probability, and regional statistical relations. The terms maximum discharge and flood are often incorrectly used as synonyms. The maximum discharge is the largest discharge in a given time interval: monthly, half a year or annual intervals and maximum discharges refer to these intervals. The discharge observation series (hydrographs) must be homogeneous if they are to be used for statistical analysis. Floods, as phenomena which occur in certain time intervals, may have different courses which can be characterized in different ways. One possibility is to provide an equation of flood hydrograph. Regional relations may be of different forms and different computational methods may be used for their development. It is proposed that static regional relations be classified according to criteria such as a number and character of explained variables as well as a number, type, and selection method of explanatory variables. Four classes are distinguished. Three for a single dimensional explained variable that differs in the selection method (geographical location, regional relations, and the selection of the statistically optimal variables). The fourth class is for the multivariate explained variable. (See also W89-05614) (Davis-PTT)
W89-05623

COMBINED REGIONAL FLOOD FREQUENCY ANALYSIS AND REGRESSION ON CATCHMENT CHARACTERISTICS BY MAXIMUM LIKELIHOOD ESTIMATION,
Institute of Hydrology, Wallingford (England).
R. J. Moore.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 119-131, 1 fig, 2 tab, 3 ref.

Descriptors: *Regional analysis, *Regression analysis, *Catchment areas, *Flood frequency, Statistical analysis, Flood forecasting, Mathematical studies, Probability distribution, United Kingdom, Flood hydrographs.

Regional flood frequency procedures are commonly based on the assumption that a single distribution obtains over a region after standardization by some statistic. The standardizing statistic is subsequently related to catchment characteristics to permit estimation of flood quantiles at ungauged sites within the region. Here, a maximum likelihood approach is developed to jointly estimate the parameters of the flood frequency distribution and the parameters relating them to catchment characteristics. Explicit standardization is thus avoided in this unified approach. Application to United Kingdom data illustrates the utility of the unified approach as a means of estimating flood quantiles, and their standard errors, at ungaged sites. In the example provided, where the shape parameter k is constant for the region, a novel method of obtaining a regional estimate of the parameter k in the generalized extreme value (GEV) distribution is also provided. Approximate expression for the standard errors of parameter and T-year flood estimates are also presented. The general technique in which the procedure is embedded is applicable to distributions other than GEV, and to other forms of dependence between the parameters, or functions of them, and catchment characteristics. The procedure is capable of practical implementation, but further work is required to assess its merits relative to existing regional flood frequency estimation procedures. The effect of intersite dependence also requires further examination. (See also W89-05614) (Author's abstract)
W89-05624

MULTIVARIATE TECHNIQUES FOR THE IDENTIFICATION OF HOMOGENEOUS FLOOD FREQUENCY REGIONS,
Geomorphological Services Ltd., Newport Pagnell (England).
S. Wiltshire, and M. Beran.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 133-145, 3 fig, 5 tab, 11 ref.

Descriptors: *Regional analysis, *Flood frequency, *Multivariate analysis, *Statistical analysis, Mathematical studies, Probability distribution, Basins, Flood forecasting.

Homogeneous collections of basins can be formed by clustering in a bivariate dataspace of coefficient of variation and specific mean annual flood. The allocation of an ungaged basin to a cluster can be achieved through the application of multivariate discriminant analysis to the basin characteristic data within the clusters. A variation of the Bayes decision rule of allocation preserves the notion of fractional cluster membership of an ungaged basin. The posterior probabilities of cluster membership are used as weighting factors in estimating a flood quantile at an ungaged site. This ensures a smooth variation of quantile values across cluster boundaries and minimizes problems arising from misallocation of basins to clusters. The judicial use of multivariate techniques provides a framework for flood estimation that is more flexible than the conventional regional analysis and is intuitively more reasonable. Its application to a set of representative hypothetical basins shows that it gives flood predictions which accord with physical reasoning and which are responsive to small differences between basins. (See also W-89) (Author's abstract)
W89-05625

SIGNIFICANCE TEST FOR HOMOGENEITY OF FLOOD FREQUENCY REGIONS,
Geomorphological Services Ltd., Newport Pagnell (England).
S. Wiltshire, and M. Beran.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 147-158, 6 fig, 2 tab, 5 ref.

Descriptors: *Homogeneity, *Regional analysis, *Flood frequency, *Statistical analysis, Mathematical studies, Flood forecasting, United Kingdom, Probability distribution, Geography, Statistical significance.

Regional flood frequency relationships are necessary for flood estimation at ungaged sites and have also gained popularity for problems on gaged rivers where they can supplement the information contained in the flood observations. A prerequisite of their development is the identification of homogeneous regions. A significance test is developed for regional homogeneity based upon the non-exceedance probabilities (termed G-points) of individual flood maxima. The power of the test is investigated in relation to region size and distribution choice. The test statistic is shown to be distributed as chi-square and for its operation, requires the adoption of a flood frequency relationship for the area under test. As an example of the use of the test, it is used to investigate the homogeneity of the geographical regions adopted in the United Kingdom Flood Studies Report. These geographic regions are, with two exceptions, shown to be heterogeneous. (See also W89-05614) (Author's abstract)
W89-05626

TESTING THE SUITABILITY OF THE TWO-COMPONENT EXTREME VALUE DISTRIBUTION FOR REGIONAL FLOOD ESTIMATION,
Institute of Hydrology, Wallingford (England).
N. Arnell, and M. Beran.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 159-175, 6 fig, 3 tab, 9 ref.

Descriptors: *Regional analysis, *Homogeneity, *Probability distribution, *Regional analysis, *Flood frequency, *Statistical analysis, Mathematical studies, United Kingdom, Flood data, Flood forecasting, Estimating, Skewed distributions.

The Two Component Extreme Value (TCEV) distribution is characterized as the maximum of two Gumbel distributions representing different flow generating processes. Some of the tests used to evaluate the suitability of the distribution for regional flood frequency analysis are described. Some geometrical properties of the distribution are outlined, and the distribution is fitted to flood data of the United Kingdom. The distribution is capable of reproducing the observed variability in sample skewness. Simulation experiments show that the TCEV estimation scheme has little bias but high variability when data are drawn from TCEV and Wakeby distributions, but displays larger bias with generalized extreme value (GEV) data. Variability increases significantly as record length decreases. The experiments also show that estimation procedures based on GEV and, to a lesser extent, Wakeby distributions do not perform well when applied to data drawn from a TCEV distribution. The contrast between population and sample skewness from TCEV parents deserves attention to explain how the outlier probability interacts with population skewness to determine sample skewness. More work is needed to determine the spatial scales on which the parameters controlling the coefficient of variation can be considered. More extended numerical experiments are needed to explore further the influence of heterogeneity and data error on the TCEV estimation algorithm. (See also W89-05614) (Author's abstract)
W89-05627

METHOD FOR ESTIMATING THE PEAK DISCHARGE THROUGH THE RECORDS OF MEAN DAILY DISCHARGE,
Florence Univ. (Italy).
P. Canuti, and U. Moisello.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 177-184, 1 tab, 2 ref.

Descriptors: *Flood peak, *Daily hydrographs, *Peak flow, *Statistical analysis, Mathematical studies, Italy, Po Valley, Flood forecasting, Probability distribution, Discharge hydrographs, Catchment areas, Climatic data, Flood frequency, Estimating, Rainfall.

The problem of estimating the peak discharge when only daily discharge data is available is discussed. The ratio between the yearly maximum of peak and daily discharge is treated as a random variable, whose distribution is lognormal. The main result of this study, conducted for a large number of Italian catchments, consists in giving the values of the two parameters (mean and standard deviation) characterizing the distribution in function of some parameters related to the physical features of the catchment. A method is given to estimate the peak discharge from daily discharge data and the corresponding estimation error is studied. The values of a correction factor, needed to avoid the estimation bias due to some regional differences, have been estimated. In the Po Valley and in central Italy, the correction coefficients do not exceed 1, while they are over 1 in southern Italy and the islands. These differences cannot be explained by the geological characteristics of the catchments and therefore the different rainfall regimes need to be taken into account. Some analyses have shown that the introduction of a variable (h sub max) cannot explain these differences, either. Therefore, they must be connected to short duration rainfalls (the cause of floods, whose characteristics actually change depending on the climatic zones. (See also W89-05614) (Author's abstract)
W89-05628

OBSERVATION AND ANALYSIS OF FLOOD DISCHARGES: EXPERIENCES FROM SWITZERLAND,
Service Hydrologique National, Bern (Switzerland).
M. Spreafico, and F. Naef.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 185-195, 8 fig, 5 ref.

Descriptors: *Switzerland, *Flood discharge, *Flood frequency, *Statistical analysis, Probability distribution, Mathematical studies, Flood forecasting, Catchment basins, Flood protection, Discharge measurement, Rainfall, Hydrologic data, Runoff, Flood peak, Frequency distribution.

Basic hydrological data is one of the essential requirements for planning and implementing flood protection measures. However, there are still many areas where such basic data is not available. A detailed analysis of most flood data from Switzerland has shown that the existing operational networks are insufficient and additional measurement stations have to be built. There is a need to quantify the accuracy of the observed data and to improve data quality for model applications. In flood frequency diagrams, the largest events of series of discharge measurements often do not coincide well with the line representing the fitted distribution. In about 100 small Swiss catchments, event parameters such as rainfall amount and duration, runoff coefficients and unit hydrographs were evaluated for the largest measured events. The range of these parameters was much larger than the range of the peak flows; the runoff intensity, that is the volume of water available for discharge in the time of concentration of the catchment, often coincided better with a fitted standard frequency distribution than did the peak flow with a similarly fitted distribution. It was concluded that out-of-channel retention introduces nonstationarity, as it attenuates flood peaks during large floods, until the retention capacity is exhausted. Then, a much larger flow is suddenly experienced. It is therefore recommended that the influence of the out-of-channel retention is assessed, when the runoff intensity fits a standard frequency distribution well but the peak flow does not. (See also W89-05614) (Author's abstract)
W89-05629

ESTIMATING THE REGULATORY FLOOD ON A DEGRADING RIVER,
Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.
B. M. Reich, and D. R. Davis.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 197-212, 3 fig, 4 tab, 24 ref.

Descriptors: *Flood recurrence interval, *Stream degradation, *Incised rivers, *Flood frequency, *Statistical analysis, Flood forecasting, Mexico, Probability distribution, Mathematical studies, Catchment areas, Flood plains, Flood protection, Estimating, Risk assessment.

Two floods that occurred in the last seven years of a 70 year gage record on a catchment crossing the Mexican/United States border have caused concern about the earlier estimate of the 100 year flood. These recent events exceed by two and three times the previous maxima which had been relatively constant for this semi-desert catchment of about 6,000 sq km. The various flood frequency computations that have been made by statistical and deterministic methods are presented. Historic descriptions of a pristine catchment and progressive channel incisement of large floodplains suggest hydrologic mechanisms that may account for the worsening flood condition. As a result, the flood regime is not stationary and is best represented by the past 25 years of record. Present flood regulatory mechanisms give no indication of how nonstationarities in the flood regime should be handled. If the flooding potential is increasing, a flood whose probability of occurrence next year is one in a hundred will be expected to occur in a period less than 100 years. A comprehensive approach to flood risk management needs to consider the expected time to the occurrence of a flood of specified magnitude as well as its annual probability of occurrence. If the flood regime continues to change as indicated, the risk of flooding will be underestimated even if the most recent record is used. (See also W89-05614) (Davis-PTT)
W89-05630

COMPARISON OF REGIONAL FLOOD FREQUENCY METHODS IN SOUTHERN ONTARIO USING ANALYSIS OF VARIANCE TECHNIQUES,
Environment Canada, Ottawa (Ontario). Water Resources Branch.
R. Condie, P. J. Pilon, K. D. Harvey, and H. Goertz.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 213-222, 2 tab, 6 ref.

Descriptors: *Regional analysis, *Ontario, *Analysis of variance, *Flood frequency, *Statistical, Flood forecasting, Canada, Probability distribution, Design floods, Mathematical studies, Comparison studies, Mathematical models, Gaging stations, Calibrations, Estimating, Catchment areas.

There are many methods of estimating design floods at locations where no site specific hydrometric data exist: rainfall-runoff models and statistical models. The following statistical models are discussed: Index flood Method using the three parameter lognormal distribution, the Direct Regression Method where T-year floods are related to physiographic and climatic parameters, and the Regional Wakeby Method. Eighty hydrometric stations were used with 40 calibration stations and 40 verification stations. After the three models were developed using the calibration stations, they were applied at the verification stations, and the deviations in the flood estimates of calibration from verification were expressed as percentages. These percentage deviations then were the data required for the Analysis of Variance (ANOVA). A three factor ANOVA was performed: method, with three levels; drainage basin size with four

ranges; and the return period of the estimated flood with three return periods. There were no significant interactions nor differences between methods. The drainage basin size was a very highly significant factor, and the return period was very nearly significant. It is emphasized that these findings apply to Southern Ontario only, and probably different conclusions would be reached if the methods were applied in different parts of Canada or the world. (See also W89-05614) (Author's abstract)
W89-05631

COMPARISON OF FLOOD FREQUENCY CURVES FOR MANY DIFFERENT REGIONS OF THE WORLD,
Institute of Hydrology, Wallingford (England). Overseas Consultancy Group.
F. A. K. Farquharson, C. S. Green, J. R. Meigh, and J. V. Sutcliffe.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 223-256, 7 fig, 6 tab, 5 ref.

Descriptors: *Regional analysis, *Flood frequency, *Statistical analysis, Probability distribution, Mathematical studies, Design floods, Flood forecasting, Hydraulic structures, Annual floods, Gaging stations, Project planning, Feasibility studies, Comparison studies.

Annual maximum flood data were collected from 1121 gauging stations in 70 different countries and were analyzed in a uniform manner to allow comparison of results between stations and between countries and larger regions. The data set comprises about 31,000 station years. For each station, the annual maximum flood series was fitted to the general extreme value distribution using the method of probability weighted moments. The derived station flood frequency curves were made dimensionless by dividing the annual maximum flood series by the mean annual flood. The station growth curves for each country or region were combined to produce a flood frequency curve intended to be representative of floods in that region. The flood frequency curves produced by this study could be used by engineers and hydrologists during planning and feasibility studies where comparable flood estimates may be required at a large number of sites and in areas where data are scarce. The regional flood frequency curves may be sufficient for design flood estimation of very small schemes or structures. The study does not yet comprise a full flood estimation procedure. To estimate the flood of any specific return period at a site, an estimate of the mean annual flood is required to complement the flood frequency curves presented. Such an estimate of the mean annual flood must be derived either from data or from comparison with adjacent gaged catchments. (See also W89-05614) (Author's abstract)
W89-05632

TWO-COMPONENT EXTREME VALUE DISTRIBUTION AND ITS POINT AND REGIONAL ESTIMATORS,
Universita di Reggio Calabria, Cosenza (Italy). Dipt. di Difesa del Suolo.
M. Fiorentino, V. P. Singh, and K. Arora.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 257-272, 2 tab, 18 ref.

Descriptors: *Regional analysis, *Estimating equations, *Flood frequency, *Statistical analysis, Flood forecasting, Probability distribution, Monte Carlo method, Entropy.

The principle of maximum entropy (POME) was used to derive the two component extreme value (TCEV) distribution which has recently been shown to account for most of the characteristics of the real flood experience. The derivation specified the information with respect to which TCEV distribution could be thought to be least biased and consistent, and yielded equations for estimation of the distribution parameters. This method of parameter estimation is suitable for application in both the site specific and regional cases. Statistical properties of this regionalized estimation procedure were evaluated using a Monte Carlo approach and compared with those of the maximum likelihood regional estimators. Regional estimates of TCEV quantiles can be attained by combining the POME estimators of shape parameters with another estimation procedure which provides good estimates of the basic component parameters. (See also W89-05614) (Author's abstract)
W89-05633

HISTORICAL FLOOD FREQUENCY DATA: ITS VALUE AND USE,
Cornell Univ., Ithaca, NY. Dept. of Environmental Engineering.
J. R. Stedinger, and T. A. Cohn.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 273-286, 5 fig, 48 ref.

Descriptors: *Historic floods, *Hydrologic data, *Hydrologic data collections, *Paleohydrology, *Flood frequency, *Statistical analysis, Flood forecasting, Mathematical studies, Design floods, Probability distribution, Estimating.

Proper interpretation of cultural, biological, and geological records of historical floods can result in improved estimates of flood quantiles. Maximum likelihood, quasimaximum likelihood, adjusted moments, and curve fitting methods for the estimation of 1, 2, and 3 parameters are considered. For a historical flood perception threshold near the 10 year flood (i.e., on average one flood in ten is above the threshold and hence is recorded), a 100 year historical period of observation provides the equivalent of roughly 40, 64, and 80 years of systematic record in terms of the variability of 100 year flood estimates when fitting 1, 2, and 3 parameter distributions, respectively. The comparable numbers for a perception threshold at the 100 year flood are 15, 20, and 45 equivalent years of systematic data when estimating 1, 2, and 3 parameters, respectively. It is concluded that historical information, when properly interpreted and utilized, should be of substantial valuc in the estimation of flood quantiles and flood risk. (See also W89-05614) (Author's abstract)
W89-05634

PALEOHYDROLOGIC DATA AND FLOOD FREQUENCY ESTIMATION,
Bureau of Reclamation, Denver, CO. Engineering and Research Center.
W. L. Lane.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 287-298, 4 fig, 2 tab, 8 ref.

Descriptors: *Paleohydrology, *Flood frequency, *Statistical analysis, Pecos River, Flood forecasting, Probability distribution, Historic floods, Frequency analysis, Mathematical studies, Estimating, Hydrologic data, Frequency distribution, Flood peak.

The Pecos River is used to illustrate the use of paleohydrologic data in estimating flood frequency distributions. Systematic, historical, and paleohydrology records are examined. The value of each of these types of records in the estimation of rare flood frequencies is demonstrated. The Pecos River is characterized by very long (100 to present) systematic records which, except for two very significant floods, indicate a well behaved frequency distribution. The peak flood flows in both 1954 and 1974 were outstandingly large and would not have been expected given only the other systematic records. Those two floods create both problems and opportunities for alternative frequency analyses. The methodology of the Interagency Advisory Committee on Water Data Bulletin 17B is used to estimate the frequency distribution under various assumptions of data availability. A serious limitation was discovered in the Bulletin 17B procedures for handling historic flood information. The limitations affect the historic flood adjustments as outlined in appendix 6 of Bulletin 17B. They do not affect the basic flood frequency procedures in Bulletin 17B and do not reduce the general usefulness of those procedures. An alternative approach is proposed and applied. The existence of paleohydrology information regarding peak flows provides a basis for additional input reflecting some of the highest flows of the last 4,500 years. These data, based upon sediment depositions, are used as a form of historic records to augment the systematic records. The general treatment of paleohydrology data requires substantial analysis before the data are in a form amenable to frequency analysis. (See also W89-05614) (Author's abstract)
W89-05635

100-YEAR FLOOD,
Arizona Univ., Tucson. Dept. of Civil Engineering and Engineering Mechanics.
E. M. Laursen.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 299-308, 2 fig, 8 ref.

Descriptors: *Historic floods, *Flood frequency, *Design floods, *Statistical analysis, Probability distribution, Hydraulic design, Mathematical studies, Flood data, Paleohydrology, Geomorphology, Arid lands, Flood forecasting.

The standards for hydraulic design have changed over the years so that now the 100-year flood is a standard for many, if not most, flood and drainage projects. Rather than a design to pass the 100-year flood, a design which curtails or suspends operations and sustains only minor damage might, in the long run, be better. A related factor is that the difference between the catastrophe which can only happen once and the recurring loss is often neglected. The need to know the magnitude of the 100 year flood leads to great efforts to predict that flood from inadequate records, usually by assuming a probability density function with an infinite tail. Because there is in actuality an upper limit (variously defined), such procedures result in undue reliance on the characteristics of the unrealistic infinite tail and can lead to misleading conclusions. An interesting line of research by geomorphologists is the investigation of paleofloods which can establish the maximum flood to be expected. Especially in arid and semi-arid regions, the flooding problem can be bank erosion, avulsion, aggradation, or degradation as well as inundation. There is a need to be able to assess the damage potential due to sedimentation effects on a probability basis similar to standard flood analysis. Sedimentation effects can be cumulative in many small floods as well as due to a single large flood. (See also W89-05614) (Author's abstract)
W89-05636

CHANGES IN HYDROLOGIC CONDITIONS RELATED TO LARGE FLOODS ON THE ESCALANTE RIVER, SOUTH-CENTRAL UTAH,
Geological Survey, Tucson, AZ.
R. H. Webb, and V. R. Baker.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 309-323, 5 fig, 3 tab, 30 ref.

Descriptors: *Hydrologic properties, *Floods, *Utah, *Channel morphology, *Flood frequency, *Statistical analysis, Escalante River, Design floods, Paleohydrology, Historic floods, Arroyos, Probability distribution, Channel erosion, Riparian vegetation, Incised rivers, Precipitation.

The history of flooding on the Escalante River in south-central Utah illustrates many problems typical of flood frequency analysis for other rivers in the southwestern United States. Floods between 1909 and 1932 eroded an arroyo as much as 300 m wide and 13 to 17 m deep from a previously unincised flood plain. A shift to increased amounts, intensity, and variability of summer precipitation corresponds with this period of channel change. Large floods have not occurred since 1940, and the channel within the arroyo walls narrowed in response to fluctuating hydrologic conditions and the spread of introduced riparian vegetation. Paleohydrologic analysis revealed that four large floods occurred during the last 400 years, with all possibly occurring between 1909 and 1932. The evidence could be equivocally interpreted to represent a stationary or nonstationary distribution of large floods, and the 100-year flood could range from 190 to 630 cu m/s, because of uncertainty in the appropriate length of the historic record. The effect of climatic shifts, changes in channel dimensions, and increases in introduced vegetation on flood frequency needs to be quantitatively assessed. Hydrologic routing models are needed to assess the effect of the channel changes, because the needed historic information on channel configurations is usually available. Historic changes in hydrologic conditions need to be evaluated for rivers in the Southwest where nonstationarity in the annual flood series is suspected. (See also W89-05614) (Author's abstract)
W89-05637

PALEOFLOOD HYDROLOGIC ANALYSIS AT UNGAGED SITES, CENTRAL AND NORTHERN AUSTRALIA,
Arizona Univ., Tucson. Dept. of Geosciences.
V. R. Baker, G. Pickup, and R. H. Webb.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 325-338, 10 fig, 19 ref.

Descriptors: *Radioactive dating, *Flood frequency, *Statistical analysis, *Paleohydrology, Geohydrology, Historic floods, Flow measurement, Australia, Northern Territory, Drainage area, Sedimentology, Discharge measurement, Deposition, Mass spectrometry.

Paleoflood hydrology is the study of past or ancient flood events that occurred prior to direct measurement by modern hydrologic procedures. Because of recent advances in flow modeling and geochronologic techniques, it is possible to perform relatively accurate evaluations of paleoflood magnitudes and ages in channels with resistant flow boundaries. Slackwater sedimentary deposits and other high water indicators are correlated along study reaches to define maximum paleoflood discharges. The procedure was tested in two regions of the Northern Territory, Australia, an area of minimal gaging information. At the Katherine Gorge site, with a drainage area of 6390 sq km, the maximum paleoflood was 6300 cu m/s. At the upper Finke Gorge site, with a drainage area of 4400 sq km, the maximum paleoflood was 5200 cu m/s. The dating of multiple paleofloods at these sites was facilitated by tandem accelerator mass spectrometry for determining 14C activity in very small organic samples. For floods in the time periods 1950 to present it is possible to achieve dating to the calendar year by reference to known curves of anomalously high atmospheric 14C activity. The treatment of such data in a flood frequency analysis requires further research, especially on the role of censoring thresholds in stacked flood slackwater depositional sequences. (See also W89-05614) (Author's abstract)
W89-05638

PALEOFLOOD HYDROLOGY AND DESIGN APPLICATIONS,
Arizona Univ., Tucson. Dept. of Geosciences.
V. R. Baker, L. L. Ely, J. E. O'Connor, and J. B. Partridge.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 339-353, 5 fig, 3 tab, 38 ref.

Descriptors: *Paleohydrology, *Design floods, *Hydraulic design, *Flood frequency, Statistical analysis, China, Historic floods, Yangtze River, Flood forecasting, Arizona, Dams, Decision making, Construction costs, Maximum probable floods.

In China historical records of floods occurring over the past 2000 years are interpreted in terms of magnitude and frequency. Such data play a major role in formulating design decisions for high risk projects, including dams on the Chang Jiang (Yangtze River). It has become possible to reconstruct paleoflood magnitudes in the United States over similar time scales as the Chinese historical floods. An example is presented from central Arizona where construction cost estimates exceed $1 billion to modify an existing system of dams for new safety standards and increased storage capacity. Paleoflood studies on the two major rivers in the project area indicate that the largest floods to occur in the last 1000 to 2000 years significantly exceed flows recorded or observed in the last century. However the paleoflood maxima are only 33% to 25% the design worst case flood values (probable maximum floods) at the respective study sites. Where it can be obtained, paleoflood information should be incorporated into the decision process. At a minimum, the physical evidence of large paleofloods should be considered to provide objective evidence of the likelihood and frequency of larger floods than can be documented in systematic or historic flood records. Current United States thinking prescribes the use of paleoflood data, to test the credibility of calculated probable maximum flood values used in the design of high hazard dams. For critical projects the paleoflood data should at least be collected, appropriately weighted, and considered in the overall decision process leading to design. (See also W89-05614) (Author's abstract)
W89-05639

BOTANICAL EVIDENCE OF FLOODS AND PALEOFLOOD HISTORY,
Geological Survey, Nashville, TN.
C. R. Hupp.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 355-369, 6 fig, 2 tab, 30 ref.

Descriptors: *Paleohydrology, *Dating, *Dendrochronology, *Riparian vegetation, *Flood frequency, Statistical analysis, Flood forecasting, Historic floods, Virginia, Shenandoah River, Flood stages, Debris, Distribution patterns.

High flood stages in conjunction with high water velocities and transported debris leave long term datable deformations in the wood and habit of riparian and flood plain vegetation. Tree ring analysis subsequently may yield evidence of floods outside the period of record. Additionally, vegetation distribution patterns may delineate areas inundated by flows of distinct duration or recurrence interval. Botanical evidence of floods along the downstream reaches of Passage Creek, Virginia, was recovered from increment cores and cross sections of flood damaged trees. Flood years were checked against gage records and known floods on Passage Creek and on nearby Shenandoah River, the Passage Creek flood stage record was extended from 1932 to 1870. Discharges of botanically determined floods were estimated using the current stage discharge rating for Passage Creek and the results of the regression. Botanical evidence also showed that no major floods occurred between intermittent stage observations on the Shenandoah River. Six additional dates of flooding prior to 1870 were determined from botanical evidence and were assigned a minimum stage necessary to affect damage to bottomland trees, thus providing a history of flooding for 265 years. Additionally, patterns of species distribution were shown to delineate terraces (flood-return period greater than 3 years), floods plains (flooded on the average once every 2 years), channel shelves (10 to 25% flow duration), and depositional bars (about 40% flow duration). (See also W89-05614) (Author's abstract)
W89-05640

IMPLICATIONS OF FLUME EXPERIMENTS FOR THE INTERPRETATION OF SLACKWATER PALEOFLOOD SEDIMENTS,
Southern Illinois Univ. at Carbondale. Dept. of Geology.
R. C. Kochel, and D. F. Ritter.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 371-390, 15 fig, 3 tab, 11 ref.

Descriptors: *Flumes, *Hydraulic models, *Sedimentology, *Floods, *Paleohydrology, Pecos River, Texas, Geomorphology, Historic floods, Tributaries, Trunk channels, Flow discharge, Deposition.

Experiments were conducted in a 12 m x 2.5 m flume to determine the properties of slackwater deposits produced during backflooding under different hydrologic and geomorphic conditions and to test some of the basic assumptions involved in using slackwater deposits to reconstruct paleoflood history. This was done by comparing observations made under controlled experimental conditions with those made in field studies along the Pecos River in west Texas. Twenty cement lined tributaries were designed to enter a trunk channel at various angles and elevations above the main channel floor. Four experimental runs were made, each having a different combination of flume slope and discharge. Thickness, grain size and maximum elevation of slackwater deposits with respect to peak main channel stage were measured. The extent of backflooding and character of the deposits varied with junction angle between tributaries and the main channel, main channel gradient, elevation of the tributary mouth, and tributary channel geometry. Properties of slackwater sediments deposited under various slope discharge combinations were consistent with field observations. These flume studies support the validity of assumptions made when using the slackwater sediment method to reconstruct paleoflood history and provide a better understanding of what criteria should be used when searching for potential slackwater sediment sites.(See also W89-05614) (Author's abstract)
W89-05641

HYDROLOGIC FREQUENCY MODELING: PROCEEDINGS OF THE INTERNATIONAL SYMPOSIUM ON FLOOD FREQUENCY AND RISK ANALYSES, 14-17 MAY 1986, LOUISIANA STATE UNIVERSITY, BATON ROUGE, U.S.A.
D. Reidel Publishing Company, Boston, MA. 1987. 645p. Edited by Vijay P. Singh.

Descriptors: *Parametric hydrology, *Flood frequency, *Statistical analysis, *Model studies, *Hydrologic models, Risks, Rainfall, Entropy.

The technology of flood frequency and risk analyses was discussed in this symposium. The objectives were: to assess the current state of the art of flood frequency and risk analyses, to demonstrate applicability of flood frequency and risk models, to establish complementary aspects of seemingly different models, to enhance interdisciplinary interaction, to discuss practice of flood frequency and risk analyses technology by federal agencies in the United States, to discuss research needs in frequency and risk analyses, and to determine directions for further research. The following topics of interest to hydrologic frequency modeling were covered: flood frequency analysis, empirical flood frequency models, mixed distributions, rainfall frequency analysis, entropy in flood frequency analysis, parameter estimation, selection of flood fre-

quency models, and multivariate stochastic models. (See W89-05643 thru W89-05686) (Davis-PTT)
W89-05642

HYDROLOGICAL AND ENGINEERING RELEVANCE OF FLOOD FREQUENCY ANALYSIS,
Geological Survey, Reston, VA.
V. Klemes.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 1-18, 30 ref.

Descriptors: *Flood frequency, *Statistical methods, *Hydrologic models, *Model studies, Probabilistic process, Engineering.

The mainstream of contemporary flood frequency analysis qualifies neither as a hydrological science nor as an engineering discipline. It is not a hydrological science because it does not analyze the frequencies of floods; it merely postulates that flood records are random samples from simple probability distributions. It is not an engineering discipline because it pays most attention to, and exerts most energy on, formal polishing of concepts which are crude by their very nature and whose basic assumptions, which have an overriding influence on design parameters, are arbitrary and are dictated by expediency rather than scientific knowledge. Much of flood frequency analysis is just a part of small sample theory in disguise, the term flood being used merely as a name for the numbers employed. At worst, flood frequency analysis is a pretentious game draining resources both from hydrology and engineering research, and a cheap opportunity to satisfy the need of academics to publish papers and supply easy topics for graduate students who know little beyond elementary statistics, probability theory, and computer programming. (See also W89-05642) (Author's abstract)
W89-05643

STATISTICAL FLOOD FREQUENCY ANALYSIS - AN OVERVIEW,
Delhi Coll. of Engineering (India).
A. Kumar, and S. Chander.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 19-35, 60 ref.

Descriptors: *Regional analysis, *Statistical methods, *Flood frequency, *Mathematical analysis, Hydrograph analysis.

Various issues involved in statistical flood frequency analysis are examined. A major component is the identification of the parent distribution to which the data belongs. The U. S. Water Resources Council issued guidelines recommending Log Pearson type III distribution for defining annual flood series. This was also recommended by the Australian Institute of Engineers. It is better able to mimic the data than other distributions studied (log normal, Gumbel, and Pearson type III). Hydrologists, dissatisfied with the Log Pearson III distribution, have searched for other distributions or transformations which can be applied to a flood series. If the objective is to have a procedure which enables good fitting to the data and also frees the analysis from distribution identification then a power transformation which employs Box-Cox transformation is probably the most appropriate one. The Water Resources Council modified report of 1981 has largely reiterated its earlier findings thereby ignoring criticism by various researchers on the recommendations. In the light of recent studies it is advocated that the recommendations need reevaluation. Regional analysis based on the Bayes approach is better than the recommended Water Resources Council practices. The ability of the Bayes estimator to compute an associated risk which can be related in economic terms makes it an important toll in regional analysis. (See also W89-05642) (Davis-PTT)
W89-05644

DETERMINISTIC NATURE OF FLOOD FREQUENCIES: SOME OBSERVATIONS,
Calgary Univ. (Alberta). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2A.
W89-05645

REVIEW OF STATISTICAL MODELS FOR FLOOD FREQUENCY ESTIMATION,
University Coll., Galway (Ireland). Dept. of Engineering Hydrology.
C. Cunnane.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 49-95, 3 fig, 3 tab, 156 ref.

Descriptors: *Statistical models, *Flood frequency, *Model studies, *Economic aspects, Frequency analysis, Mathematical studies, Index Flood method, Catchment areas, China.

The relation between flood frequency estimates and the economic decision making process is discussed and selected developments in frequency analysis are traced in tabular form. The main types of frequency analysis procedures and models are surveyed including at-site, at-site/regional and regional only cases. The at-site/regional cases include Index Flood, Bayesian and TCEV methods. Criteria for selecting a frequency analysis procedure are discussed under two headings, descriptive ability and predictive ability. The former relates to a model's ability to preserve statistics of observed flood series while the latter relates to quantile estimating ability in a robust manner. The relative merits of different types of flood quantile estimators are discussed, beginning with at-site estimators and the search for a robust at-site estimator. This is followed by the principal results available about at-site/regional quantile estimators. Further topics considered are regional homogeneity of flood statistical behavior, the effect of spatial and temporal interdependence of flood magnitudes, and the detection and use of historical floods. (See also W89-05642) (Author's abstract)
W89-05646

ESTIMATION OF FLOOD FREQUENCIES BY A NONPARAMETRIC DENSITY PROCEDURE,
Ottawa Univ. (Ontario). Dept. of Civil Engineering.
K. Adamowski, and C. Labatiuk.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 97-106, 3 fig, 5 tab, 14 ref.

Descriptors: *Statistical models, *Flood frequency, *Model studies, *Parametric hydrology, Nonparametric methods, Monte Carlo method, Snowmelt, Thunderstorms, Probability distribution.

Annual flood risk is usually estimated by fitting an a priori assumed probability distribution function to the observed annual extreme peak series (parametric method). The main shortcomings of such a procedure are: the selection of a distribution, reliability of parameters (especially for skewed data with short record length), inability to analyze multimodal distributions resulting from flooding due to snowmelt versus thunderstorm activity, and treatment of outliers. A new methodology has been developed based on the nonparametric concepts for estimation of probability density function. The nonparametric kernel method overcomes some of the limitations inherent in the parametric method, and was developed based on a few and very mild assumptions. Based on the numerical results using real data and Monte Carlo simulation, it was found that the nonparametric flood estimates are accurate and suitable for multimodal densities. (See also W89-05642) (Author's abstract)
W89-05647

STATISTICAL MODELS FOR FLOOD FREQUENCY ESTIMATION OF THE MISSISSIPPI AND YAZOO RIVERS,
University of Southern Mississippi, Hattiesburg. Dept. of Economics.
E. Nissan.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 107-115, 3 tab, 5 ref.

Descriptors: *Flood forecasting, *Statistical models, *Probability distribution, *Mississippi River, *Yazoo River, *Model studies, Mississippi, Vicksburg, Army Corps of Engineers.

The application of the theory of extreme values to predict the magnitudes of annual floods for the Mississippi and Yazoo Rivers based on maximum annual levels of the rivers between 1925 and 1975 was investigated. The data were first tested to establish an initial probability distribution of the yearly extreme values. It was found by means of goodness of fit tests that both the normal distribution and the log normal distribution adequately describe the extreme probability distributions for both rivers. Then, by using techniques developed by Cramer, the expectations and variances of the mth extremes were calculated. The theory regarding the distribution of the mth extreme is primarily based on order statistics. From the estimates of these two parameters, probability predictions of the level of floods for any return period may be obtained. The predicted values of floods for return periods of 100, 200, and 300 years are presented. Both the normal and log normal distributions may be used to advantage to fit a sample of size $n = 51$ years of the maximum yearly observations. The statistical methods are easy to follow and calculations are easy to carry out. The procedure may also be used to analyze data for a particular month or a particular week within a year. (See also W89-05642) (Davis-PTT)
W89-05648

PARTIAL DURATION SERIES WITH LOG-NORMAL DISTRIBUTED PEAK VALUES,
Technical Univ. of Denmark, Lyngby. Inst. of Hydrodynamics and Hydraulic Engineering.
D. Rosbjerg.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 117-129, 4 fig, 1 tab, 2 ref.

Descriptors: *Duration analysis, *Flood frequency, *Model studies, *Statistical methods, *Wave height, *Flood forecasting, *North Sea, *Wave height, Mathematical analysis, Hydrologic models, Monte Carlo method.

The T-year estimate in a partial duration series with log-normal distributed peak exceedances was analyzed in case of parameter estimation by means of the maximum likelihood method and the method of moments, respectively. Approximate expressions for bias and variance of the T-year estimate were developed, and it was found that the sample variance of the log-normal distribution parameters is the main reason for the uncertainty of the T-year estimate, whereas the sample variance of the intensity of the process is of minor importance. Providing smaller bias (in absolute terms) and smaller variance the maximum likelihood method was found to be superior to the method of moments. The two methods produce bias of different signs, positive bias in case of maximum likelihood estimation and negative in case of estimation by method of moments. The variance expression in the case of maximum likelihood estimation is to some extent verified by Monte Carlo simulation obtained from a study of significant wave heights. The purpose of the investigation was to assess the 50 year significant wave height for a specific location in the North Sea on the basis of 17 years of hindcasted wave data together with the standard deviation of

the estimate. (See also W89-05642) (Author's abstract)
W89-05649

ESTIMATION OF A PRIOR DISTRIBUTION FOR THE BAYESIAN ESTIMATION OF PEARSON III SKEWS,
Utah Univ., Salt Lake City. Dept. of Civil Engineering.
U. Lall.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 131-147, 5 tab, 17 ref.

Descriptors: *Pearson distribution, *Probability distribution, *Statistical models, *Mathematical analysis, *Flood frequency, *Streamflow forecasting, Hydrologic models.

The Pearson III distribution is often used as a model for the annual maximum streamflow process. Estimates of flood quantiles and the probabilities of exceedance of flood magnitudes, using this distribution and the small samples usually available, are biased. The importance of unbiased estimates of skew is recognized. The development of such unbiased estimators, using regional and/or site information has met with limited success. This has contributed to the controversy surrounding the use of the Pearson III distribution to model the flood frequency process. A general framework was developed for the estimation of a prior distribution for skews using Bayesian estimation techniques for a region where some data on annual maximum streamflows is available. Sampling distributions for a sample skew estimated from a sample size, using flood flow data from regional stations, where the parent population skew is unknown, can be derived for a number of sample sizes, through resampling and subsampling techniques. The objective is then the determination of a prior distribution that yields the observed sampling distributions upon convolution with the sampling distributions, over some admissible set and for all sample sizes. The prior probability distribution derived for regional skew can be used to develop unbiased Bayesian estimators of skew using site data. A framework is provided for the use of regional information in developing at site skew estimators. The framework can be extended to the estimation of flood quantiles and probabilities with uncertain skew. The techniques developed are applied to data from 314 United States gaging stations, that have no diversion or regulation of flow, and have at least 60 years of annual maximum data. (See also W89-05642) (Author's abstract)
W89-05650

COMPARISON OF FLOOD-FREQUENCY ESTIMATES BASED ON OBSERVED AND MODEL-GENERATED PEAK FLOWS,
Geological Survey, Reston, VA. Water Resources Div.
W. O. Thomas.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 149-161, 7 tab, 18 ref.

Descriptors: *Statistical models, *Flood frequency, *Rainfall-runoff relationships, *Hydrological studies, *Model studies, Flood discharge, Alabama, Georgia, Illinois, Mississippi, Missouri, Tennessee, Delaware, Maryland, Kansas, Oklahoma, Parametric hydrology.

Comparisons were made of flood frequency estimates from a rainfall/runoff model and from observed annual peak data to determine if these estimates exhibited the same statistical variability. The analysis was based on data at 173 stations in 10 States where there were 20 or more years of observed annual peak data and flood frequency estimates from a rainfall/runoff model. Paired t tests and analysis of variance techniques indicated that there were statistically significant differences between the two sets of flood frequency estimates. These differences existed for different recurrence interval floods (2-, 10-, 50-, and 100-years), different watershed sizes, and different States. These differences appeared to be primarily related to three infiltration parameters in the rainfall/runoff model and to a lesser extent the observed record length at the station. Furthermore, the ratio of the model generated 100-year flood discharge to the 2-year flood discharge was 3.98 whereas the same ratio based on observed peak flows was 5.72. Additional research is needed to identify what factors cause the flood estimates from the rainfall/runoff model appear to exhibit less variability than flood estimates based on observed peak flow records. (See also W89-05642) (Author's abstract)
W89-05651

FLOOD FREQUENCY ANALYSIS USING BOX-COX TRANSFORMATION BASED GUMBEL EV-I DISTRIBUTION,
National Inst. of Hydrology, Roorkee (India).
M. Perumal, R. D. Singh, and S. M. Seth.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 163-172, 2 fig, 1 tab, 9 ref.

Descriptors: *Flood frequency, *Statistical Methods, *Hydrologic models, *Model studies, Parametric hydrology, Gumbel distribution, Monte Carlo method, Box-Cox transformation.

An attempt was made to develop a methodology for transforming the annual peak flood series to the form of Gumbel EV-I distribution using Box-Cox transformation. The exponent lambda of the Box-Cox transformation has been estimated by trial and error using the method of maximum likelihood and method of probability weighted moments to obtain nearly the same estimate of log likelihood functions by both methods. This methodology has been applied to 1000 samples of various sample sizes of randomly generated synthetic flood series which follow the Pearson type-III distribution. The statistical estimates of the reduced variates of the Gumbel EV-I distributed transformed series (mean and standard deviation) have been found nearer to 0.5772 and 1.2825 as required from theoretical considerations and thus verifying the applicability of the proposed methodology for transforming to Gumbel EV-I distribution. (See also W89-05642) (Author's abstract)
W89-05652

FLOOD-FREQUENCY ANALYSIS WITH HISTORICAL DATA IN CHINA,
Geological Survey, Atlanta, GA. Water Resources Div.
V. B. Sauer.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 173-182, 2 fig, 3 ref.

Descriptors: *Flood forecasting, *Hydrologic models, *Statistical methods, *China, *Flood frequency, Historic floods, History, Flood peak.

The Chinese have been involved in an intensive search for historical flood data since the early 1950's; and consequently, they have found reliable flood elevations and other information regarding relative flood heights, for thousands of sites in many river basins, mostly in the eastern half of China. Information has been found at a few sites to establish flood elevations for extraordinary events occurring as much as 2,000 years ago. Peak discharges for many of the historical flood events have been quantified by using stage-discharge relations, hydraulic equations, and by hydraulic models. The Chinese have used the historical data extensively in their analyses of flood frequency for design purposes. Frequency curves were developed by a combination of analytical and graphical methods, with the Pearson Type III distribution and Weibull plotting positions. The upper part of the curves are strongly influenced by the historical data. In some instances an objective function was used to minimize the differences between the fitted curve and the data points. The method is described as a combination of mathematical and graphical fitting. Strong emphasis is placed on the importance of finding and using reliable historic data. (See also W89-05642) (Davis-PTT)
W89-05653

DEVELOPMENT OF A VERSATILE FLOOD FREQUENCY METHODOLOGY AND ITS APPLICATION TO FLOOD SERIES FROM DIFFERENT COUNTRIES,
Illinois State Water Survey Div., Champaign.
K. P. Singh.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 183-197, 4 fig, 2 tab, 18 ref.

Descriptors: *Flood frequency, *Flood forecasting, *Statistical methods, *Hydrologic models, Monte Carlo method, Japan, Poland, Czechoslovakia, Italy, United States, Russia, Rainfall, Snowmelt, Flood plain flow.

Many observed annual flood series exhibit reverse curvatures when plotted on lognormal probability paper. The occurrence of reverse curvature may be attributed to factors such as dominance of within the channel or floodplain flow, seasonal variation in flood producing storm types, variability in antecedent soil moisture and cover conditions, and a mixture of rainfall and snowmelt floods. A transform has been developed which considers the probability distribution of observed flood series as a mixture of the probabilities of two lognormal distributions. Distribution parameters can be significantly biased if the observed flood series has outliers and inliers. The distributions of outliers and inliers for various size samples and at various probabilities or significance levels have been developed from extensive Monte Carlo experiments. The objective detection and modification of any outliers and inliers in an observed flood series is an integral part of the versatile flood frequency methodology. Results presented for flood series from seven basins in Japan, the U.S.S.R., Poland, Czechoslovakia, Italy, and the United States show the versatility and superiority of the proposed methodology in detecting and modifying any outliers/inliers and yielding reliable flood estimates. (See also W89-05642) (Author's abstract)
W89-05654

HYDROCLIMATICALLY-DEFINED MIXED DISTRIBUTIONS IN PARTIAL DURATION FLOOD SERIES,
Louisiana State Univ., Baton Rouge. Dept. of Geography and Anthropology.
K. K. Hirschboeck.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 199-212, 7 fig,2 tab, 14 ref.

Descriptors: *Flood frequency, *Statistical Models, *Climatic data, Hydrologic data, Rainfall-runoff relationships, Gila River, Parametric hydrology, Flood peak.

The possibility of mixed distributions in flood series has been recognized and attempts to separate records into homogeneous subsets have been encouraged. Climate is often proposed as a source of mixed distributions, but the separation of flood records into climatic subgroups has tended to focus on seasonal divisions or a partitioning of the flood series into rainfall and snowmelt generated events. A detailed hydroclimatic analysis was used to categorize floods on the basis of the synoptic weather patterns which produced them. This procedure represents the first attempt to classify events in a partial duration flood series according to the spe-

cific climatic flood generating mechanism responsible for each event. The technique identifies mixed distributions by using physically based information that is independent of the runoff series, rather than by defining subpopulations on the basis of the shape of the parent distribution itself. Mixed distributions were defined in peak flow data for 30 gaging stations in the climatically sensitive Gila River basin in Arizona for the period 1950-1980. The flood events were hydroclimatically classified into eight main categories using surface and upper air weather maps and precipitation data. The analysis demonstrated that floods in the basin originate from a variety of atmospheric processes and suggested that the parameters of the flood frequency distributions of different hydroclimatic subgroups may have a physical basis. Refinement of the technique and larger sample sizes could result in improved parameter estimates of the component distributions, as well as a better understanding of the physical basis for rare flood events. (See also W89-05642) (Davis-PTT)
W89-05655

MIXED FLOOD DISTRIBUTIONS IN WISCONSIN,
Wisconsin Univ., Madison. Dept. of Civil and Environmental Engineering.
T. Diehl, and K. W. Potter.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 213-226, 9 fig, 11 ref.

Descriptors: *Flood frequency, *Statistical models, *Hydrologic data, *Wisconsin, Seasonal distribution, Runoff rates, Black River, Hay River, Kickapoo River, Sugar River, Galena River, Snowmelt, Madison, Wausau, Spooner, Rainfall-runoff relationships.

Traditional flood frequency analysis is predicated on the assumption that the annual flood series can be considered to be a sample from a single population. In Wisconsin this is not a valid assumption. Wisconsin floods are of two types which are hydrologically and statistically distinct. An analysis of the time of occurrence of Wisconsin floods indicates two dominant flood seasons: spring and summer. Late May is the boundary between these two seasons. Using May 20 as the date of separation, parallel spring and summer flood series were constructed for all Wisconsin partial flood series with ten or more years of record (29 series). Based on the two sample Kolmogorov-Smirnov test the hypothesis that spring and summer floods are identically distributed was rejected for 18 of the 29 pairs of flood series. This is interpreted as convincing evidence that spring and summer floods in Wisconsin generally have distinct statistical distributions. An analysis of runoff data for 8 of the 29 partial series gages demonstrates that spring and summer floods in Wisconsin are also hydrologically distinct. Spring floods show relatively high runoff-precipitation ratios. Summer floods show relatively low ratios. Future work is needed to understand better the hydrology of spring and summer floods and to determine if and how this understanding can improve quantile estimation. (See also W89-05642) (Author's abstract)
W89-05656

FLOOD DATA, UNDERLYING DISTRIBUTION, ANALYSIS, AND REFINEMENT,
Illinois State Water Survey Div., Champaign.
K. P. Singh.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 227-241, 4 fig, 17 ref.

Descriptors: *Flood frequency, *Statistical models, *Hydrologic data, Drought, Storms, Illinois, Statistical analysis, Distribution patterns.

Annual flood peak data must conform to certain standards of quality control, sample size, and homogeneity for use in flood frequency analysis. Sometimes the values for the highest observed floods of an annual flood series are much higher or much lower than expected; these values are designated at outliers and inliers, respectively. Analyses of storms producing high floods perceived as outliers and droughts containing low floods perceived as outliers provide a physical basis for their being outliers. However, these outliers and inliers need to be detected and properly modified to derive unbiased design flood estimates. Test statistics have been developed for objective detection of any outliers/inliers in a given flood series after converting it to a normally distributed series with the power transformation. A design flood estimation methodology was developed which uses three distributions: normal with power transformation, log-Pearson type III, and mixed distribution with two components. Using a computer program package, any outliers/inliers are detected and modified sequentially from the 0.01 to the 0.4 significance level. Examples addressing flood series with outliers and inliers are drawn from rivers in Illinois. (See also W89-05642) (Davis-PTT)
W89-05657

ANALYSIS OF FLOOD OCCURRENCE THROUGH CHARACTERIZATION OF PRECIPITATION PATTERNS,
Kyushu Univ., Fukuoka (Japan). Dept. of Civil Engineering.
A. Kawamura, K. Jinno, T. Ueda, and R. R. Medina.
IN: Regional Flood Frequency Analysis: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 327-336, 3 fig, 4 tab, 6 ref.

Descriptors: *Time series analysis, *Rainfall rate, *Flood forecasting, *Statistical models, *Japan, Monthly distributions, Precipitation record, Fukuoka City, Kalman filter, Hydrologic models, Parametric hydrology.

The occurrences of floods were investigated by analyzing the monthly precipitation time sequence utilizing ordinary Kalman filter (OKF) and adaptive Kalman filter (AKF). OKF identifies the abnormal precipitation periods in the sequence by comparing the observed and average precipitation patterns. AKF detects the changes in the precipitation pattern by associating them with the abrupt changes in the parameters of the periodic model of the precipitation time sequence. The 92-yr-long precipitation record at Fukuoka City, Japan shows three types of abnormal precipitation periods, which exhibit different degrees of possibility of flood occurrence. In addition, it shows nine precipitation epochs with different precipitation patterns. The model parameters estimated by AKF in one epoch characterize its precipitation pattern and describe the occurrences of the abnormal precipitation periods, revealing whether the risk of flood occurrence is high or not in the epoch. Characterized by the highest estimate of mean, epoch VII (December 1947-July 1956) had the highest risk of flood occurrence. (See also W89-05642) (Davis-PTT)
W89-05665

ENTROPY AND PROBABILITY DISTRIBUTIONS,
Lanzhou Univ. (China).
For primary bibliographic entry see Field 7C.
W89-05668

EVALUATION OF SEVEN METHODS FOR ESTIMATING PARAMETERS OF EVI DISTRIBUTION,
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 7C.
W89-05669

FITTING LOG PEARSON TYPE 3 DISTRIBUTION BY MAXIMUM LIKELIHOOD,
Saint Johns River Water Management District, Palatka, FL.
For primary bibliographic entry see Field 7C.
W89-05670

ESTIMATING THE PARAMETERS OF THE GENERALIZED GAMMA DISTRIBUTION BY MIXED MOMENTS,
Asian Inst. of Tech., Bangkok (Thailand).
For primary bibliographic entry see Field 7C.
W89-05671

ASSESSMENT OF USE OF AT-SITE AND REGIONAL FLOOD DATA FOR FLOOD FREQUENCY ESTIMATION,
University Coll., Galway (Ireland). Dept. of Engineering Hydrology.
For primary bibliographic entry see Field 7C.
W89-05673

EMPIRICAL STUDY OF PROBABILITY DISTRIBUTIONS OF ANNUAL MAXIMUM FLOODS,
Purdue Univ., Lafayette, IN. School of Civil Engineering.
For primary bibliographic entry see Field 7C.
W89-05674

COMPARISON OF SOME FLOOD FREQUENCY DISTRIBUTIONS USING EMPIRICAL DATA,
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 7C.
W89-05675

USE OF HISTORICAL DATA IN FLOOD-FREQUENCY ANALYSIS,
Centro de Pesquisas de Energia Eletrica, Rio de Janeiro (Brazil).
For primary bibliographic entry see Field 7C.
W89-05676

1983 IGUACU RIVER FLOOD: EFFECT OF A RARE FLOOD ON FREQUENCY ANALYSES,
Universidade Federal do Parana, Curitiba (Brazil).
H. D. Fill, M. R. Borstel Sugai, and N. L. Pinto.
IN: Hydrologic Frequency Modeling: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 499-504, 4 tab, 8 ref.

Descriptors: *Frequency analysis, *Statistical analysis, *Flood forecasting, *Design floods, *Flood frequency, Brazil, Iguacu River, Probability distribution.

Methods of flood frequency analysis used in engineering studies were evaluated and criticized on the basis of actual hydrological data which include a recent extraordinary flood. The analysis was restricted to the 67,300 sq km Iguacu River basin, almost entirely situated in Brazilian territory. The criteria for selection of the best theoretical frequency distribution were analyzed and verified to be clearly dependent on the extension of the series and on subjective decisions such as the selection of class intervals. Design flood estimates are dramatically influenced by the extension of the hydrological series or theoretical probability distribution function. The relativity of such a concept as the 10,000 yr design flood, either due to limitations of the existing sample or to the subjectivity of the methodology used, has become evident. (See also W89-05642) (Author's abstract)
W89-05677

ANALYSIS OF FLOOD FREQUENCIES IN THE CAUVERY VALLEY,
National Inst. of Engineering, Mysore (India).
M. Ramesh, M. C. S. Murthy, and R. Prasad.
IN: Hydrologic Frequency Modeling: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana

State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 505-513, 3 fig, 3 tab, 5 ref.

Descriptors: *Peak flow, *Frequency analysis, *Statistical analysis, *Flood forecasting, *Reservoir design, *Flood frequency, India, Cauvery River, Probability distribution, Reservoir construction, Reservoir capacity, Spillway capacity.

Annual peak flood records from ten subbasins in the upper reaches of the river Cauvery in south India were analyzed. Floods of longer return periods correlated well with the drainage area of the subbasin; the correlation for floods of short return periods was poor. Correlation with normal annual rainfall in the subbasin was also poor. Return periods for design floods based on empirical formulae, used in the region for small reservoirs (called tanks), were calculated using the fitted distributions. The Log Pearson III distribution performed better than the Gumbel distribution in predicting flood frequencies in the upper Cauvery subbasins; however, the formulae are much too high in relation to the expected life of the tanks in all cases but one. This suggests that while the majority of the tank spillways were overdesigned, some would be underdesigned. This conclusion is also supported by the fact that breach due to inadequate spillway capacity is rare. (See also W89-05642) (Author's abstract)
W89-05678

MULTIVARIATE STOCHASTIC FLOOD ANALYSIS USING ENTROPY,
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 7C.
W89-05679

MULTIVARIATE PARTIAL DURATION SERIES IN FLOOD RISK ANALYSIS,
Director-General for Natural Resources, Lisbon (Portugal).
F. N. Correia.
IN: Hydrologic Frequency Modeling: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 541-554, 4 fig, 8 tab, 10 ref.

Descriptors: *Duration analysis, *Risk analysis, *Frequency analysis, *Statistical analysis, *Flood forecasting, *Portugal, *Flood frequency, Mathematical studies, Design floods, Flood discharge, Risks, Flood peak.

Flood frequency and risk analysis play a crucial role in the design of many hydraulic structures and water resources systems. Traditionally only the annual flood peak discharges were considered in the flood risk assessment process. An alternative approach is the use of partial duration series. This approach has proven to be particularly suitable when short records are available. In this method not only the annual maxima are considered but all the peaks over a given threshold. When using this method it is very attractive to extend the results presented in the literature to include the flood volume and flood duration in the risk assessment process, instead of considering only the flood peak discharges. Data from the following twelve Portuguese river basins are used to document the applicability of multivariate partial duration series and its limitations: Beca, Corgo, Sabor, Paiva, Alva, Simonte, Tera, Degebe, Pena, Corona, Odelouca, and Arao. Additional research is needed before final conclusions can be formulated with respect to the general use of multivariate partial duration series. (See also W89-05642) (Davis-PTT)
W89-05680

ANOTHER LOOK AT THE JOINT PROBABILITY OF RAINFALL AND RUNOFF,
Oklahoma State Univ., Stillwater. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 2A.
W89-05681

BIVARIATE FLOOD MODEL AND ITS APPLICATION,
Technische Univ., Graz (Austria). Inst. for Hydromechanics, Hydraulics and Hydrology.
B. Sackl, and H. Bergmann.
IN: Hydrologic Frequency Modeling: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 571-582, 16 fig, 8 ref.

Descriptors: *Frequency analysis, *Flood frequency, *Hydrologic models, *Model studies, *Statistical analysis, *Design floods, *Probability distributions, Flood frequency, Mathematical studies.

A bivariate model uses flood peak and flood volume of direct runoff as the two characteristic variables of a flood event. The model can also be applied to other bivariate problems in hydrology. The bivariate normal distribution was chosen as the parent bivariate distribution function. It is necessary to transform the marginal distributions of both samples into normal distributions. The theoretical bi-normal distribution is fitted and tested using the equi-lines of probability density function (ISO-PDF-lines). The model offers various possibilities of probability interpretation. ISO-PDF-lines show a range within which a certain percentage of events lie. The conditional distributions of one variable can be computed for a constant value of the other variable, which shows the probability by which the variable is reached or exceeded for the other fixed variable. A useful calculation is given by the probability of quadrants statistic. The upper right probability of a certain pair of values defines the probability of events with both characteristics being higher than those of the presumed values. Applying this method to the planning of flood protection projects, design flood events of chosen probabilities are determined by a certain equi-line of quadrants probability. (See also W89-05642) (Author's abstract)
W89-05682

ANALYSIS AND SIMULATION OF THREE-COMPONENT FLOODS IN THE OHIO RIVER BASIN,
Ohio Univ., Athens. Dept. of Civil Engineering.
T. J. Chang.
IN: Hydrologic Frequency Modeling: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 583-594, 3 fig, 2 tab, 14 ref.

Descriptors: *Duration analysis, *Model studies, *Statistical models, *Flood frequency, *Design floods, *Ohio River, Discharge measurement, Flood control, Mathematical studies, Simulation analysis, Streamflow, Parametric hydrology.

Flood series, including three components, namely, the occurrence time, the discharge volume, and the flood duration, are formed from observed daily streamflows. The intensity function describing the flood occurrence rate is derived assuming the nonhomogeneous Poisson process. A fitted equation is applied to the estimated intensity function to generate the flood occurrence times which are expressed by a sequence of time intervals. The procedure of the marked point process is introduced to link the flood duration and the discharge volume, which are modeled, respectively, by exponential distributions, to the flood occurrence time. The simulated result consists of a three-component flood series including the occurrence time, the flood duration and the discharge volume, which can be used for environmental pollution protection and flood-control purposes. The statistical comparisons made between the generated and the observed series agree reasonably well. (See also W89-05642) (Author's abstract)
W89-05683

PROBABILISTIC MODEL FOR FLOODING DOWNSTREAM OF THE JUNCTION OF TWO RIVERS,
Universidad Nacional Autonoma de Mexico, Mexico City. Facultad de Ingenieria.
J. A. Raynal, and J. D. Salas.
IN: Hydrologic Frequency Modeling: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 595-602, 1 fig, 1 tab, 9 ref, append. NSF Grant ECE-8612307.

Descriptors: *Model studies, *Statistical analysis, *Flood frequency, *Frequency analysis, *Design floods, *Probability distribution, Parametric hydrology, Rivers, Bear River, Dry Creek, Mathematical studies, Probabilistic process.

Flood frequency analysis downstream of the junction of two rivers, when flood information is available upstream of the confluence, is discussed. It is assumed that the joint distribution function of the floods at two upstream gaging stations follows a bivariate extreme value distribution. The distribution at the junction is obtained by the convolution integral which gives the distribution of the sum of two random variables. The model was applied to an actual case, Bear River and Dry Creek, and shown to be a good approximation. It is expected that for gaging stations with longer periods of recorded flows, the results will improve significantly. (See also W89-05642) (Author's abstract)
W89-05684

CONCURRENT FLOODING PROBABILITIES,
Missouri Univ.-Rolla. Dept. of Civil Engineering.
C. D. Morris, and L. C. Wilson.
IN: Hydrologic Frequency Modeling: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 603-614, 4 tab, 8 ref.

Descriptors: *Statistical analysis, *Flood forecasting, *Flood frequency, *Mississippi River, *Probability distribution, Meramec River, Missouri, Design floods, Mathematical studies, Tributaries, Flood stages, Flood peak, Confluent streams.

Concurrent flooding is the flooding at a location due to two or more causative factors. The estimation of stage probabilities is important to hydrologic engineers and becomes complex where a location can be inundated due to flooding of two or more rivers. A probability concept of concurrent flooding was developed to determine flooding probabilities on a tributary river where the stage-flow relationship on the tributary is affected by backwater due to a flooding event on a nearby main river. A systematic approach for determining concurrent flooding probabilities, called the critical combination method, was developed and applied to the Meramec River near its confluence with the Mississippi River in Missouri. The data consists of mean daily values, instead of the typically used peak values. A critical combination is a tributary river flow and main river stage pair that could combine to cause a yearly peak stage at a point on the tributary. The stage resulting from each critical combination, computed using a backwater program, produces an annual stage series to which a probability distribution can be fitted. This procedure was used in the Meramec and Mississippi case and shown to be a valid approach. (See also W89-05642) (Author's abstract)
W89-05685

BIVARIATE ANALYSIS OF CONCURRENT FLOODING,
Missouri Univ.-Rolla. Dept. of Civil Engineering.
C. D. Morris, and S. J. Calise.
IN: Hydrologic Frequency Modeling: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 615-632, 1 tab, 16 ref.

Descriptors: *Statistical analysis, *Flood forecasting, *Flood frequency, *Mississippi River, Meramec River, Missouri, Design floods, Mathematical

studies, Tributaries, Probability distribution, Flood flow, Flood stages, Reoers, Confluent streams.

The probability of concurrent flooding near and around the confluence of the Meramec and Mississippi Rivers in Missouri was investigated. A bivariate probability method was developed which utilizes the fit of a bivariate probability distribution in order to describe the probability relationship between tributary river flow and main river stage. A backwater program is used for the conversion of the tributary river. The method also implements the theory of total probability so that all flow/stage combinations which could have created a given stage on the tributary river are accounted for in the probability computations. An important aspect of the proposed methodology is its applicability to basins which have limited periods of record. This application is accomplished by using relationships developed between short-term gage and nearby longer-term gage to estimate the parameters required to fit the bivariate probability distribution. (See also W89-05642) (Author's abstract)
W89-05686

NORTH LYNN DRAINAGE SCHEME: HYDRAULIC MODEL STUDIES,
British Hydromechanics Research Association, Cranfield (England).
For primary bibliographic entry see Field 8B.
W89-05749

MONTHLY STREAMFLOW AND GROUNDWATER CONDITIONS IN THE UNITED STATES AND SOUTHERN CANADA, WATER YEARS 1945-85,
Geological Survey, Reston, VA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W89-05771

DISSOLVED AND SUSPENDED MATERIAL TRANSPORTED BY THE POTOMAC RIVER AT CHAIN BRIDGE, AT WASHINGTON, D.C., WATER YEARS 1978-81,
Geological Survey, Richmond, VA. Water Resources Div.
For primary bibliographic entry see Field 5B.
W89-05773

FLOOD OF OCTOBER 1986 AT SEWARD, ALASKA,
Geological Survey, Anchorage, AK. Water Resources Div.
S. H. Jones, and C. Zenone.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 87-4278, 1988. 43 p, 29 fig, 5 tab, 2 plates, 39 ref.

Descriptors: *Alaska, *Floods, *Erosion, Kenai Peninsula, Seward, Flood-frequency analysis, Flood hazards, Alluvial fans, Landslides, Debris flows, Debris avalanches.

Intensive rainfall, as much as 15 inches at Seward within one 24-hour period, caused catastrophic flooding in most area streams. Severe erosion along steep-gradient, mountain canyon reaches and the subsequent deposition of sediment and debris on alluvial-fan surfaces below canyon mouths damaged or destroyed bridges, roads, and homes. Landslides and debris flows blocked upper reaches of several streams. Failure of these temporary dams generated debris-laden floods, which far exceeded any previously known peak flows in those streams; the estimated peak discharge of such a 'surge-release' flood at Spruce Creek (13,600 cubic feet per second) was four times as great as the previously known maximum flow from that basin. The largest calculated natural runoff rate (unaffected by surge release) was 1,020 cubic feet per second per square mile from the 1-square-mile drainage basin of Rudolph Creek. Peak floodflows determined by slope-area methods are listed for 10 stream sites. The report includes discussion of possible sources of error in using indirect methods to determine peak flood discharges from steep-gradient streams, and compares peak discharge values for 10 streams calculated by using three methods. (USGS)
W89-05779

2F. Groundwater

HYDROGEOLOGY OF SEDIMENTARY BASINS: APPLICATION TO EXPLORATION AND EXPLOITATION.
Third Canadian/American Conference on Hydrogeology. National Water Well Association, Dublin, OH. 1986. 275p. Edited by Brain Hitchon, Stefan Bachu, and Claude M. Sauveplane.

Descriptors: *Geohydrology, *Underground waste disposal, *Conferences, *Sedimentary basins, *Exploitation, *Exploration, Waste disposal, Sediment-water interfaces, Oil, Minerals.

This volume contains the Proceedings of The Third Canadian/American Conference on Hydrogeology, which was jointly organized by the Alberta Research Council and the National Water Well Association, and held at Banff, Alberta, Canada, June 1986. The subject of the conference was 'Hydrogeology of Sedimentary Basins: Application to Exploration and Exploitation'. The Canadian/American Conferences on Hydrogeology comprise both invited speakers and unsolicited papers. The papers are gathered into four broad sections generally corresponding to the subjects covered by the invited specialists. These categories are: Petroleum and Mineral Exploration; General Basin Studies; Water-Rock Interaction; and Deep Waste Disposal. (See W89-04566 thru W89-04585) (Hammond-PTT)
W89-04565

MODELS OF SUBSURFACE HYDROLOGY OF SEDIMENTARY BASINS,
Alberta Univ., Edmonton. Dept. of Geology.
J. Toth.
IN: Hydrogeology of Sedimentary Basins: Application to Exploration and Exploitation. National Water Well Association, Dublin, OH. 1986. p 1-18, 32 fig, 2 tab, 72 ref.

Descriptors: *Hydrologic models, *Subsurface water, *Groundwater movement, *Hydrology, *Sedimentary basins, *Model studies, Fluid flow, Flow pattern, Compaction, Gravity studies, Thermal expansion, Geophysics, Natural resources, Exploitation.

Basinal water flow is responsible for numerous subsurface processes and phenomena, including the transport of matter and heat, ahydrostatic fluid pressures, and diagenetic mineral changes, and may result in, or indicate, exploitable resources of water, metallic and non-metallic minerals, geothermal heat and petroleum. A knowledge of the volumes, rates and directions of formation water low and their changes through geologic times is valuable in the exploration for natural resources. Basinal water flow cannot be observed directly and the portrayal of its pattern and evolutionary history must rely on indirect observations and models. Numerous models of subsurface hydrology have been formulated for sedimentary basins over the years ranging from purely conceptual to highly quantitative, from lumped to distributive, from stochastic to deterministic; considering a variety of driving mechanisms such as compaction, thermal convection and expansion, osmosis, mineral diagenesis, and gravity; and ranging in objectives from abstract understanding to targeted exploration. An attempt is made to review the essential features and intended objectives of some models of subsurface hydrology that affect, or have affected, perceptions of fluid flow in sedimentary basins. The examples discussed include the compaction drive flow models of Bonham, Jacquin and Poulet, and Bethke; the water exchange modes of Kartsev and Vagin, and Domenico and Robbins, the effects of temperature on basinal flow according to concepts of Magara, Welte and Yukler, and Palciauskas and Domenico; osmotic effects proposed by Berry, and Bredehoeft et al.; and the gravity drive dominated series of flow modes of Munn, Hubbert, Coustau et al., Toth, Galloway, and Garven. (See also W89-00565) (Author's abstract)
W89-04566

FLUID MOVEMENT IN DEEP SEDIMENTARY BASINS: A REVIEW,
Amoco Corp., Tulsa, OK.
J. S. Bradley.
IN: Hydrogeology of Sedimentary Basins: Application to Exploration and Exploitation. National Water Well Association, Dublin, OH. 1986. p 19-31, 28 fig, 34 ref.

Descriptors: *Groundwater movement, *Brines, *Geohydrology, *Geochemistry, *Diagenesis, *Sedimentary Basins, Chemical properties, Model studies, Compaction, Thermal expansion, Convection, Meteoric water, Seawater, Fluid flow.

To predict the changes in reservoir quality by diagenesis, it is essential to understand fluid movement and fluid chemistry in a sedimentary basin. This report establishes a physical model of a simple subsiding basin in order to place realistic limits on parameters, which, when combined with a future chemical model, will define zones of solution and precipitation within the modeled basin. It is found that the principal sources of subsurface waters are sea water and meteoric water. The brines can leave the rocks only at the surface. The principal drive for the brine is the loss of porosity due to diagenesis. Displacement drives by meteoric waters generally become minor with depth. Compaction, thermal effects, and intraformational convection are minor drives. When all the drives are summed, the movement of fluid with respect to the sedimentary rock is found to be relatively small. To invoke large volumes of brine through the rock for diagenesis requires a focusing mechanism, which necessarily implies a transient or a local, not regional, effect on the diagenesis of the rock. (See also W89-04565) (Author's abstract)
W89-04567

HYDRODYNAMIC FRAMEWORK OF SOME SEDIMENTARY BASINS,
Societe Nationale Elf-Aquitaine, Paris (France).
A. Chiarelli.
IN: Hydrogeology of Sedimentary Basins: Application to Exploration and Exploitation. National Water Well Association, Dublin, OH. 1986. p 32-41, 28 fig, 8 ref.

Descriptors: *Aquifer characteristics, *Hydrologic systems, *Geohydrology, *Sedimentary basins, *Flow patterns, *Hydrodynamics, Compaction, Hydraulics, Reservoirs, Pressure Distribution, Aquifers, Gravity flow.

The Dogger reservoir beds of the Paris Basin are characterized by gravity flow with gentle hydraulic gradients stretching from the outcrops located near the Massif Central, the Ardennes and the Vosges mountains, in the direction of the English Channel. The South Aquitaine Basin shows two systems for the Cretaceous and Jurassic aquifers. To the north, a gravity flow system has significant hydraulic gradients and fresh waters. To the south, a quasi-static flow system has saline waters and abnormal pressures, locally linked to some discontinuous reservoirs. The formation waters of the Western Gabon Basin are nearly static due to slight differences in elevation between the onshore aquifer outcrops and the sea. There are abnormal pressures where the Tertiary aquifers become discontinuous. On the Douala Basin, for every formation, two different hydrodynamic systems can be distinguished. Near the outcrops the aquifer pressures are normal. The aquifer pressures become abnormal as the depth increases and the sand content falls below a certain level. The Arabic Gulf Province shows a broad gravity flow system stretching from Saudi Arabian and Iranian outcrops toward the Gulf. High abnormal pressures have been encountered which are linked to evaporitic systems and discontinuous reservoirs. The Jurassic aquifers of the Viking Graben have extremely abnormal pressures. Abnormal pressures are limited to the zones in the graben with the maximum subsidence of Cretaceous and Tertiary sediments. The pres-

sure anomalies are associated with compaction anomalies. The large variations in hydraulic head are related to important discontinuities in the sedimentary series. The Eastern Algerian Sahara shows two distinct areas: the Northeast Sahara Basin, where the hydrocarbon reservoirs are sealed both vertically and laterally under abnormal high pressures; and the Southeast Sahara Basin, where slightly saline waters flow by gravity from the outcrops toward the central part of the basin. (See also W89-04565) (Author's abstract)
W89-04568

DEEP WATER DISCHARGE: KEY TO HYDROCARBON AND MINERAL DEPOSITS,
Hydrexco, Houston, TX.
W. H. Roberts.
IN: Hydrogeology of Sedimentary Basins: Application to Exploration and Exploitation. National Water Well Association, Dublin, OH. 1986. p 42-68, 62 fig, 111 ref.

Descriptors: *Groundwater movement, *Geochemistry, *Deposition, *Geologic formations, *Geohydrology, *Hydrocarbons, *Minerals, Flow discharge, Sedimentary Basins.

Based on the observed hydrogeology of sedimentary basins containing hydrocarbon and mineral deposits, it is concluded that transient waters are essential to the gathering of components and the forming of those deposits where they are found. The habitats of hydrocarbon and mineral deposits are geologically and hydrologically similar, and in some cases coincident. In all cases, the deposits are found where the depressuring and cooling of source waters has occurred due to focused deep water discharge. Because basinal waters move continuously under forced-draft conditions, the residence times of hydrocarbon and/or mineral deposits are always subject to a steady-state dynamic relation with transient waters. Current observations indicate that the deposits are continuously updated according to evolving hydrogeologic conditions, subject to reasonable lag times. (See also W89-04569) (Hammond-PTT)
W89-04569

HYDROGEOLOGY AND ABNORMAL PORE PRESSURES IN THE BEAUFORT-MACKENZIE BASIN: PRELIMINARY RESULTS ALONG TWO CROSS SECTIONS,
Alberta Research Council, Edmonton.
C. M. Sauveplane, and P. Mortensen.
IN: Hydrogeology of Sedimentary Basins: Application to Exploration and Exploitation. National Water Well Association, Dublin, OH. 1986. p 75-86, 6 fig, 2 tab, 20 ref.

Descriptors: *Geohydrology, *Pore pressure, *Sedimentary basins, *Cross-sections, *Canada, Thermal expansion, Gravity flow, Pressure distribution, Hydrocarbons.

Abnormal pore pressures are common in sedimentary basins. Rapid deposition of regressive sequences, diapirism and growth faults are the classical sedimentologic and tectonic environments for their occurrence. Associated anomalies of geothermal gradients have been observed. Compaction flow in restricted conditions, aquathermal pressuring, osmosis and diagenetic changes are usually invoked to explain their origin and maintenance. These theories fail to account for the three-dimensional gravity-driven flow of formation waters. Since the Cretaceous, an important recharge area has probably existed along the southwestern edge (Richardson Mountains) of the Beaufort-Mackenzie Basin, indicating that the genetic role of gravity-driven flow for the Tertiary sequence should not be neglected a priori. The methodology used and some preliminary results along two cross sections are discussed in this paper. The hydrogeological study is aimed first at a careful regional delineation of the anomalous zones for pore pressure and temperature and prior to any interpretative analysis. Pore pressure anomalies can be up to 80 megapascals at 4km depth. Transmissivity contrasts of up to 6000 exist between the sand-shale aquifers and the shale dominant aquitards. Local rates of variations for pore pressure and temperature are not necessarily parallel and trends of return to normal conditions with increasing depth can be observed with the available data. Lateral correlations of anomalous zones between faulted blocks are, in most instances, speculative. (See also W89-04565) (Author's abstract)
W89-04570

HYDROGEOLOGICAL CONTROLS AND INDICATORS OF THE PECHELBRONN OIL DEPOSITS UPPER RHINEGRABEN: A PRELIMINARY SYNTHESIS,
Alberta Univ., Edmonton. Dept. of Geology.
C. J. Otto, and J. Toth.
IN: Hydrogeology of Sedimentary Basins: Application to Exploration and Exploitation. National Water Well Association, Dublin, OH. 1986. p 105-106, 2 fig.

Descriptors: *Oil fields, *Geohydrology, *Groundwater, *Groundwater movement, Flow pattern, Gravity flow, Hydrocarbons, Hydraulics, Geological fractures, Simulation analysis.

The Pechelbronn oil deposits are located in the Upper Rhinegraben in Alsace, France, and constitute Europe's first commercially exploited hydrocarbon accumulation. A preliminary, simple flow simulation has confirmed a flow pattern with an area of ascending flow around the Pechelbronn area. Steady-state flow conditions can be assumed because no significant boundary condition (such as erosional hiatus during the Rhinegraben evolution) are noted, which may have caused the a flow pattern reversal. The last tectonic activity, which created second-order faults, enabled the formation waters to ascend along these more conductive fault zones, possibly resulting in an easterly shift of the geothermal anomaly, observed today east of Soultz. Oil is trapped in Mesozoic limestones, but mainly in Tertiary sandstones or alluvial fan sand lenses, mostly in stratigraphic and/or fault-controlled reservoirs. The hydrocarbons, driven by gravity flow of groundwater and buoyancy, must have migrated, over a short distance because the source rock is believed to be in the near vicinity of the reservoir rocks. Hydrocarbons have been entrapped in lenticular and/or fault-controlled reservoirs by a combination of structural and hydrodynamic trapping. Zones of fluid potential minima can be postulated in regions of oppositely directed water flow. These stagnant zones are potential hydrodynamic traps. The reservoirs are aligned parallel to the normal faults and the spatial distribution pattern of the hydrogeological phenomena coincides with the oil fields. In regions where the graben is flanked by uneven topographic highs, hydrocarbons are accumulated on the side with lower walls. A steeper hydraulic gradient flow from the higher Black Forest mountains toward the graben possibly transported or remigrated hydrocarbons to their present sites. (See also W89-04565) (Hammond-PTT)
W89-04571

PETROLEUM HYDROGEOLOGY: A HYDROGEOLOGICAL APPROACH TO PETROLEUM EXPLORATION AND BASIN ANALYSIS,
Port Harcourt Univ. (Nigeria). Dept. of Geology.
D. U. Ophori, and J. Toth.
IN: Hydrogeology of Sedimentary Basins: Application to Exploration and Exploitation. National Water Well Association, Dublin, OH. 1986. p 108-111, 1 fig, 1 tab, 9 ref.

Descriptors: *Exploration, *Solute transport, *Petroleum hydrogeology, *Geohydrology, *Oil, *Sedimentary basins, Groundwater, Exploitation, Chemical properties, Groundwater movement, Flow discharge, Fluid flow, Hydrocarbons.

Petroleum hydrogeology is defined as the application of hydrogeological principles and techniques to petroleum exploration and basin analysis. The basic tenet is that ground water in motion in a regional setting ablates, transports and accumulates substances, including hydrocarbons, from recharge to discharge areas in a predictable manner. Converging limbs of ground water flow systems may form hydraulic traps that are favorable sites for hydrocarbon accumulation in discharge areas. Hydrodynamic traps can be created by barriers to ground water movement due to permeability variations and relatively impermeable geological structures. With the recognition of these relations, a comprehensive hydrogeologically based approach to petroleum exploration can be formulated. Petroleum hydrogeology may be applied in the: (1) recognition and ranking of prospective regions of large areal extent; (2) estimation of potentially migrated hydrocarbon volumes; (3) location of hydraulic and hydrodynamic traps, and extrapolation of known accumulations; and (4) detection and evaluation of direct indications of petroleum deposits. Proposed exploration techniques include the mapping and analysis of natural phenomena related to regional formation-fluid flow, and the observation and modeling of regional hydraulic head and fluid pressure patterns. Thus, once fully developed, petroleum hydrogeology may be expected to complement, or rank equal in effectiveness, to geology, geophysics and geochemistry at various stages of exploration for petroleum. (See also W89-04565) (Author's abstract)
W89-04572

INTEGRATED HYDROGEOLOGICAL DATA BASES: THEIR USE AND MISUSE,
Alberta Research Council, Edmonton.
B. Hitchon, S. Bachu, A. T. Lytviak, and C. M. Sauveplane.
IN: Hydrogeology of Sedimentary Basins: Application to Exploration and Exploitation. National Water Well Association, Dublin, OH. 1986. p 115-117, 2 ref.

Descriptors: *Data interpretation, *Geohydrology, *Data collections, *Data processing, *Data storage and retrieval, Statistical methods, Spatial distribution.

Dynamic Basin Analysis integrates conventional basin analysis with understanding of formation fluids, and analysis of fluid and heat flow and mass transport. It requires development of a data base management system, specialized data processing methods (point data to synthesized information) and modeling/simulation techniques. Five main classes of data and the different processing methods used for each type are discussed. Spatially distributed data, and data with a continuous distribution can be processed by conversion to a regular grid using spatial interpolation. Data with a discontinuous distribution is best represented by statistical distributions, such as log cumulative frequency plots. Scale is the third attribute of data, and the four types (nominal, ordinal, interval and ratio) are each limited as to the degree of mathematical manipulation that can be used. The importance of separating measured from processed data in the data base is emphasized. The fifth class is termed dependent data because to process it requires other data types with possibly different degrees of confidence. Although not strictly a data type, the presence of 'mountains' and 'black holes' in contoured data suggests erroneous data, which require human intervention. It is important to understand the nature of these five data classes because each requires fundamentally different data processing techniques. Data base management systems must be flexible with extensive cross-indexing to different programs for the different data processing requirements. (See also W89-04565) (Author's abstract)
W89-04573

PRELIMINARY ANALYSIS OF TRANSPORT PROCESSES IN THE BASAL CAMBRIAN AQUIFER OF SOUTH-CENTRAL ALBERTA,
Alberta Research Council, Edmonton.
S. Bachu, B. Hitchon, and P. Mortensen.
IN: Hydrogeology of Sedimentary Basins: Application to Exploration and Exploitation. National Water Well Association, Dublin, OH. 1986. p 118-126, 4 fig, 19 ref.

Descriptors: *Heat transfer, *Groundwater movement, *Solute transport, *Aquifer characteristics, *Alberta, Aquifers, Groundwater, Data collections, Groundwater movement, Flow pattern, Conductivity, Permeability coefficient, Tempera-

ture, Dimensional analysis, Geological formations, Canada, Stratigraphy.

The Basal Cambrian Sandstone in Alberta diachronously overlies the Precambrian basement, being defined by stratigraphic position rather than by either chronostratigraphic or lithostratigraphic criteria. The aquifer boundaries are the eastern limit of the disturbed belt in the west, the Middle Cambrian erosional edge to the north, and the provincial boundaries to the south and east. The aquifer thickness ranges from 10.6 to 115.0 m over an area of 180,000 sq km, with an areal average of 43 m. The aquifer is continuous, and semiconfined everywhere by the overlying Mount Whyte-Earlie aquitard. The formation waters in the aquifer flow from the disturbed belt toward the east-northeast, with an average lateral gradient of 1.0 m/km. The average porosity of the aquifer is 0.1. Due to the low permeability, the velocity of fluid flow is very low, corresponding to a specific discharge of 0.8 cm/a. Dimensional analysis shows that the main mechanism for heat transfer in the Basal Cambrian Aquifer is diffusion (conduction) through the solid matrix and the fluid, while the main mechanisms for solute transport are mechanical dispersion and convection by the formation waters. The trend of temperature distribution at the bottom of the Basal Cambrian Aquifer correlates with the isopach of the entire sedimentary column, showing that the topography, stratigraphy and lithology of the sediments are the main factors controlling the heat flow in the basin. Only the Swan Hills area are the temperatures at the Precambrian surface higher than warranted by the previously mention factors, pointing to a possible thermal anomaly. (See also W89-04565) (Hammond-PTT)
W89-04574

GEOTHERMAL REGIMES AND GEOTHERMAL RESOURCES OF SEDIMENTARY BASINS,
Geological Survey of Canada, Ottawa (Ontario).
A. M. Jessop.
IN: Hydrogeology of Sedimentary Basins: Application to Exploration and Exploitation. National Water Well Association, Dublin, OH. 1986. p 127-139, 10 fig, 34 ref.

Descriptors: *Geothermal studies, *Heat transfer, *Geohydrology, *Sedimentary basins, *Geothermal resources, *Groundwater movement, Aquifers, Groundwater Heat flow, Geophysics, Conduction, Convection, Canada.

One of the major assumptions underlying the science of geothermics over the last 100 years has been that heat is transported through the earth's crust only by conduction, except in the immediate vicinity of active volcanoes. In old shields this assumption may be justifiable, but in sedimentary basins the ability of water to move through permeable aquifers provides a means of heat transport that may under certain conditions be as effective as conduction. In some basins widespread contrasts of heat flow are observed, both laterally and vertically, suggesting forced convection by water migration. It is also evident that the patterns of water flow may have been changed drastically over the life of the sediments by orogenic events. The platform of western Canada is a good example of such potential for change. In basins where the surface is above sea level a hydrological drive may be inferred from the topographic surface. In subsea basins this drive is not available in the same form. Nevertheless, patterns of heat-flow variation have been observed for which some form of water flow seems to be the most probable explanation. A complete quantitative description of the thermal state of any basin too complex to acquire or store, even for present thermal regimes. To extend this description to the geological past presents even greater difficulties. Only an understanding of the principles and processes that control the thermal state of basins can be established, so that detailed description of small parts of interest may be developed. (See also W89-04565) (Author's abstract)
W89-04575

CHLORINE-36 DATING OF OLD GROUND WATER IN SEDIMENTARY BASINS,
New Mexico Inst. of Mining and Technology, Socorro. Dept. of Geoscience.
F. M. Phillips, H. W. Bentley, and D. Elmore.
IN: Hydrogeology of Sedimentary Basins: Application to Exploration and Exploitation. National Water Well Association, Dublin, OH. 1986. p 143-150, 10 fig, 28 ref.

Descriptors: *Sedimentary Basins, *Groundwater dating, *Chlorine radioisotopes, *Paleohydrology, *Radioactive dating, *Geohydrology, Radioisotopes, Carbon radioisotopes, Radioactive half-life, Atmospheric physics, Sedimentary rocks, Australia, Alberta, Aquifers.

Most ground water in deep sedimentary basins is too old to be dated by C14. An anionic, conservative, radionuclide produced mainly in the atmosphere, with a half-life much longer than C14, is necessary in order to date such waters. Cl36 meets these requirements. It has a half life of 301,000 years, is produced by spallation of atmospheric argon, and is not typically adsorbed on, or reactive with, sedimentary rocks. The Cl36 dating techniques were successfully tested on ground water from the Great Artesian Basin of Australia and the Milk River Aquifer in Alberta. Waters from both basins were shown to have residence times exceeding one million years. Cl36 appears to have widespread applicability to dating old ground water in sedimentary basins. (See also W89-04565) (Author's abstract)
W89-04576

HEAT FLOW IN THE EDMONTON-COLD LAKE REGION OF THE WESTERN CANADIAN SEDIMENTARY BASIN AND THE INFLUENCE OF FLUID FLOW,
Alberta Univ., Edmonton.
J. A. Majorowicz, F. W. Jones, M. E. Ertman, A. Linville, and K. Osadetz.
IN: Hydrogeology of Sedimentary Basins: Application to Exploration and Exploitation. National Water Well Association, Dublin, OH. 1986. p 151-158, 10 fig, 32 ref.

Descriptors: *Sedimentary basins, *Heat flow, *Groundwater, *Geohydrology, *Fluid flow, *Canada, Hydrodynamics, Aquitards, Groundwater flow, Flow pattern, Geothermal studies, Carbonates, Salts, Conductivity, Numerical analysis.

Heat flow estimates from 'time' corrected bottom hole temperature data, net rock information, and rock thermal conductivities have been made for 1021 single township/range areas corresponding to the 1:1,000,000 scale Edmonton map sheet (NN-12 international Map of the World). The increase in heat flow coincides with decreasing sediment thickness and with decreasing topographic elevation. The high heat flows in the platform area lie adjacent to the low heat flow Churchill Province in the shield area where the average value is 44 +/-7mW/sq m. Higher average heat generation occurs in the Churchill basement beneath the sediments than in the shield area; this may account for part of the difference. The perturbation to the thermal regime by dipping layers of conductive salt beds and carbonates along a NE-SW profile across the area may cause a difference. This has been investigated by a two-dimensional numerical method, but no significant surface effect was observed. Another possible explanation is that part of the anomalous heat flow is related to the hydrodynamic effect. To account for the heat flow difference of 20-30 mW/sq m, water velocities of the order of 10 to the minus 9th power to 10 to the minus 10th power m/s through aquitards are required. These values are contrary to results from hydrogeological studies of the Cold Lake region, which is part of the present study area. Nevertheless, the high heat flows in the study area are part of the large scale heat flow feature which has been interpreted as being related to a regional hydrodynamic effect. (See also W88-04565) (Author's abstract)
W89-04577

USE OF THERMAL DATA TO RESOLVE AND DELINEATE HYDROLOGIC FLOW SYSTEMS IN SEDIMENTARY BASINS: AN EXAMPLE FROM THE UINTA BASIN, UTAH,
Utah Univ., Salt Lake City. Dept. of Geology and Geophysics.
S. D. Willett, and D. S. Chapman.
IN: Hydrogeology of Sedimentary Basins: Application to Exploration and Exploitation. National Water Well Association, Dublin, OH. 1986. p 159-168, 16 fig, 22 ref.

Descriptors: *Groundwater, *Geohydrology, *Sedimentary basins, *Geothermal studies, *Groundwater movement, *Utah, Hydrodynamics Heat flow, Fluid flow, Flow pattern, Model studies, Statistical methods, Thermal conductivity, Stochastic hydrology, Lithology, Topography.

Recent analysis of thermal data from both marine and continental sedimentary basins have revealed lateral and vertical variations in the temperature field within basins that can be interpreted as resulting from active groundwater flow systems. Similar patterns could also result from thermal conductivity heterogeneities or local variation in basement heat flow. The relative importance of these processes can be determined by careful analysis of the present-day thermal field. A method is presented for analyzing thermal states of basins that integrates types of data most commonly available: both hole temperatures from exploration drill holes, conventional heat flow measurements, thermal conductivity measurements or estimates, and depth of lithology contacts. By treating temperature, thermal conductivity,and heat flow as stochastic processes within a basin, the maximum likelihood estimate of the temperature field is obtained throughout the basin. Statistically significant variance in this estimate can be interpreted as a hydrologic perturbation. Interpretation of possible ground water flow systems is aided by numerical modeling of the coupled heat and fluid flow. By incorporating basin structure and thermal conductivity we can resolve and quantitatively model these active flow systems. This analysis is applied to the Uinta Basin, a Laramide compression basin in northeast Utah, where we find lateral temperature variations that are too large to be accounted for by conductivity contrasts. This result is consistent with previous studies. These temperature variations are interpreted in the context of a regional ground water flow system as driven by large topographic relief north of the basin. (See also W89-04565) (Author's abstract)
W89-04578

ORIGIN AND EVOLUTION OF WATER AND SOLUTES IN SEDIMENTARY BASINS,
Geological Survey, Menlo Park, CA.
Y. K. Kharaka.
IN: Hydrogeology of Sedimentary Basins: Application to Exploration and Exploitation. National Water Well Association, Dublin, OH. 1986. p 173-195, 23 fig, 6 tab, 98 ref.

Descriptors: *Paleohydrology, *Geohydrology, *Sedimentary basins, *Solutes, Sediment-water interface, Chemical properties, Connate water, Meteoric water, Minerals, Salinity, Decarboxylation, Bacteria, Organic matter, Tracers.

Formation waters with salinities ranging from about 5000 mg/L to > 350,000 mg/L dissolved solids play a major role in the physicochemical processes found in sedimentary basins. These waters are mainly meteoric or connate marine in origin. Evaporated seawater trapped in salt at the time of precipitation and subsequently squeezed in to the bittern connate water, geologically old meteoric water and waters of mixed origin also are important components in several sedimentary basins. The original waters have evolved to Na-Cl, Na-Cl-CH3COO, or Na-Ca-Cl type waters by a combination of the following processes: (1) dissolution of halite; (2) incorporation of bitterns; (3) dissolution and precipitation of minerals other than halite; (4) interaction of the waters with organic matter present in sedimentary rocks; (5) interaction with rocks, principally clays, siltstones, and shales, that behave as geological membranes; and (6) diffusion. The important processes responsible for the chemical composition of water in each basin can be identified using 'chemical markers' and isotopes. The discovery in these waters of high concentra-

tions mono- and dicarboxylic acid anions, phenols and other reactive organic species has led to numerous field and laboratory studies to determine their distribution and importance in inorganic and organic interactions. The observed concentrations are minimum values because these organics are degraded by bacteria and decarboxylated thermally. Decarboxylation rates obtained for acetic acid in laboratory studies, however, cannot be used to estimate the original concentrations because they are strongly influenced by the catalytic effects of the containers used; the rates are highly variable giving half-life values of 10 to > 10 to the 9th power years at 100 C. Decarboxylation rates estimated from field data, give an average half-life value of 20 million years at 100 C. (See also W89-04565) (Author's abstract)
W89-04579

SOLMNEQF: A COMPUTER CODE FOR GEOCHEMICAL MODELING OF WATER-ROCK INTERACTIONS IN SEDIMENTARY BASINS,
Battelle Project Management Div., Willowbrook, IL.
P. K. Agganwal, R. W. Hull, W. D. Gunter, and Y. K. Kharaka.
IN: Hydrogeology of Sedimentary Basins: Application to Exploration and Exploitation. National Water Well Association, Dublin, OH. 1986. p 196-203, 3 fig, 3 tab, 26 ref.

Descriptors: *Computer programs, *Geohydrology, *Water chemistry, *Sedimentary basins, *Geochemistry, Chemical properties, *Model studies, Data collections, Simulation analysis, Mathematical studies, Minerals, Temperature.

SOLMNEQF is a modified, FORTRAN version of the geochemical program SOLMNEQ. In addition to an improved algorithm for faster execution, the modifications in SOLMNEQF include an extended data base and several options for the distribution of species with an imposed condition of equilibrium. SOLMNEQF can be used to simulate the effects on pH and saturation states of minerals due to (1) a change in temperature; (2) addition of gases (CO_2, H_2S, or NH_3) lost before pH measurement; (3) isothermal mixing of two solutions; (4) precipitation/dissolution of a given amount of a solid; and (5) addition or loss of steam. (See also W89-04565) (Author's abstract)
W89-04580

MINERALOGICAL AND OXYGEN-ISOTOPE STUDIES OF CLASTIC DIAGENESIS: IMPLICATIONS FOR FLUID FLOW IN SEDIMENTARY BASINS,
University of Western Ontario, London. Dept. of Geology.
F. J. Longstaffe.
IN: Hydrogeology of Sedimentary Basins: Application to Exploration and Exploitation. National Water Well Association, Dublin, OH. 1986. p 204-220, 19 fig, 1 tab, 88 ref.

Descriptors: *Sedimentary basins, *Diagenesis, *Geochemistry, *Fluid flow, *Mineralogy, *Oxygen isotopes, Chemical properties, Groundwater movement, Hydrocarbons, Petrography, Alberta.

Mineral diagenesis has numerous direct consequences for the exploration and exploitation of hydrocarbons. The mineralogical, chemical and oxygen isotope compositions of diagenetic minerals can also be used to estimate the temperatures attained by sandstones or shales during diagenesis. The implications for mass transport, pore water evolution, and groundwater movement in sedimentary basins also are important. For example, the occurrence of diagenetic quartz overgrowths in sandstones is common, yet the source and mode of transport of the silica is uncertain. One explanation requires the movement of silica-rich pore waters from shales and mudstones into sandy units, requiring huge volumes of additional water for sufficient transfer of silica in solution. Several hypotheses have been generated to resolve this apparent 'water shortage'. Without pore waters to analyze, the oxygen-isotope compositions of diagenetic minerals, combined with some knowledge of their relative order of crystallization, can be used to identify the contribution of fluids to sedimentary basins. Such data can also be used in reconstructing pore water evolution during diagenesis. Studies of the Upper Cretaceous basal Belly River sandstone and the Lower Cretaceous Viking Formation from Alberta indicate that the early diagenetic minerals formed from pore waters varying in composition from sea water to fresh water, depending upon depositional environment. Following O18-enrichment of pore waters during water/rock interaction during burial diagenesis, the rocks subsequently experienced a large influx of meteoric water around the time of maximum burial; meteoric water dominated the latter stages of diagenesis in these units. (See also W89-04565) (Author's abstract)
W89-04581

MODELING OF OXYGEN ISOTOPES IN FORMATION WATERS - REVIEW OF THE PRINCIPLES WITH EXAMPLES,
W. W. Dickinson.
IN: Hydrogeology of Sedimentary Basins: Application to Exploration and Exploitation. National Water Well Association, Dublin, OH. 1986. p 221-229, 5 fig, 2 tab, 15 ref.

Descriptors: *Geochemistry, *Geohydrology, *Groundwater, *Oxygen isotopes, *Diagenesis, Sedimentary basins, Sediment-water interface, Chemical properties, *Model studies, Minerals, Mathematical studies, Isotope studies, Paleohydrology, Calcite, Quartz, Illite.

Isotopic modeling of delta-O18 water provides a possible alternative and allows constraints to be placed on the interpretation of measured data if present waters are not available for sampling or paleo-waters are suspected of being involved in the precipitation of authigenic minerals. Isotopic models are of most use when a closed system is specified as this allows comparison of measured delta-O18 data to a set of controlled variables. The closed system model acts as a gage for natural or open systems. The modification of delta-O18 water which may be caused by diagenetic reactions at elevated temperatures, is modeled from two mass balance equations. Three diagenetic reactions used to modify delta-O18 water include: detrital limestone to calcite cement, detrital quartz to quartz cement, and detrital clay to authigenic illite. A weighted average delta-O18 water and delta-O18 of calcite, quartz, and illite in equilibrium with this water are calculated at 500m increments. For a closed system model, calculated variables at one depth are used for input variables at the next depth. An open system can be crudely simulated by adjusting the input variables at the next depth. An open system can be crudely simulated by adjusting the input variables at each depth. General trends in delta-O18 appear to be similar for modeled and measured basin waters. This suggests that the assumptions and principles used in modeling are a good approximation of the mechanisms which control delta-O18 of formation waters in natural environments. (See also W89-04565) (Author's abstract)
W89-04582

PROCEEDINGS OF THE ENVIRONMENTAL PROBLEMS IN KARST TERRANES AND THEIR SOLUTIONS CONFERENCE.
For primary bibliographic entry see Field 5C.
W89-04586

CHARACTERISATION OF CARBONATE AQUIFERS: A CONCEPTUAL BASE,
Bristol Univ. (England). Dept. of Geography.
P. L. Smart, and S. L. Hobbs.
IN: Proceedings of the Environmental Problems in Karst Terranes and Their Solutions Conference. National Water Well Association, Dublin, OH. 1986. p 1-14, 7 fig, 25 ref.

Descriptors: *Model studies, *Karst hydrology, *Groundwater movement, *Groundwater storage, *Groundwater recharge, *Aquifers, *Hydrology, Recharge, Storage, Flow, Groundwater management.

The three fundamental attributes governing the behavior of carbonate aquifers are recharge, storage and transmission. Failure to recognize their independent nature has resulted in considerable confusion in the literature. A model is proposed in which all three attributes are ranged between end members giving a 3 dimensional field into which carbonate aquifers may be plotted. For recharge, the end members considered are concentrated and dispersed inputs; for transmission, conduit and diffuse flow; and for storage, unsaturated and permanently saturated stores. The (1) may be applied to problems concerning water resources development and protection, (2) e.g. to simulate the effects of various development strategies based on aquifer type or to use specific measurements to establish aquifer type. (See also W89-04586) (Hammond-PTT)
W89-04587

MODELS AND METHODS FOR SHALLOW CONDUIT-FLOW CARBONATE AQUIFERS,
Kentucky Univ., Lexington. Dept. of Geology.
For primary bibliographic entry see Field 5B.
W89-04588

PREDICTION OF CONTAMINANT PATHS IN KARST AQUIFERS,
State Univ. of New York Coll. at Oneonta.
For primary bibliographic entry see Field 5B.
W89-04589

WATER MOVEMENT AND STORAGE IN THE UNSATURATED ZONE OF A MATURELY KARSTIFIED CARBONATE AQUIFER, MENDIP HILLS, ENGLAND,
Bristol Univ. (England). Dept. of Geography.
P. L. Smart, and H. Friederich.
IN: Proceedings of the Environmental Problems in Karst Terranes and Their Solutions Conference. National Water Well Association, Dublin, OH. 1986. p 59-87, 11 fig, 5 tab, 38 ref.

Descriptors: *Quarries, *Groundwater pollution, *Mendip Hills, England, *Groundwater movement, *Karst hydrology, Limestone, Storage, Flow pattern, Tracers, Quantitative analysis, Dye releases, Landfills, Groundwater recharge, Vadose water.

Quantitative and tracer studies of autogenic recharge processes in the unsaturated zone of the Carboniferous Limestone aquifer indicated the great importance of a shallow zone of enhanced solutional porosity in the upper part of the bedrock, the subcutaneous zone. At low recharge rates, flow was predominantly vertical via many low capacity routes but, as rates increased, lateral flow switched recharge to vertical shafts capable of much higher discharges. This zone also contributed to the considerable storage present in the unsaturated zone, which was comparable in magnitude to that of the saturated aquifer. These findings have practical implications in relation to groundwater pollution from landfill sites in limestone areas which have been developed in abandoned quarries. With adequate design to distribute and limit recharge such sites may be developed without detrimental effects on water quality because they are sited in the most impermeable portion of the limestone aquifer. (See also W89-04586) (Hammond-PTT)
W89-04590

SEASONAL, HYDROGEOLOGIC, AND LAND-USE CONTROLS ON NITRATE CONTAMINATION OF CARBONATE GROUND WATERS,
Pennsylvania State Univ., University Park.
For primary bibliographic entry see Field 5B.
W89-04591

TIME-SERIES ANALYSIS OF EDWARDS AQUIFER SPRINGS IN COMAL COUNTY, TEXAS,
SRH Associates, Inc., Portland, OR.
S. R. Rothermel, and A. E. Ogden.
IN: Proceedings of the Environmental Problems in

Karst Terranes and Their Solutions Conference. National Water Well Association, Dublin, OH. 1986. p 115-148, 22 fig, 19 ref.

Descriptors: *Groundwater movement, *Texas, *Edwards Aquifer, *Karst hydrology, *Water chemistry, *Groundwater recharge, *Springs, *Time series analysis, Aquifers, Recharge, Hydrology, Chemical properties, Flow, Dye releases, Comparison studies, Dams, Limestone, Geohydrology, Fault springs, Streamflow, Seasonal variation, Water temperature, Hardness, Sulfate, Nitrate, Chloride, Magnesium, Calcium.

Hueco and Comal Springs are two of the largest limestone springs in Texas, but are endangered by the growing use of the Edwards Aquifer in the San Antonio Region. A time-series analysis of water chemistry and a dye-tracing study were used to understand the two flow regimes and to determine if building local recharge structures could ensure spring flow. Comal Springs showed seasonal trends in total hardness, calcium hardness, magnesium hardness, and sulfate. Longer-term, gradual discharge changes corresponded with changes in the hardness, chloride, and nitrate concentrations. Discharge, temperature, nitrate, and sulfate changed markedly during individual storm events, but the effect was temporary. A tritium value of 5 0.T.U. was obtained from Comal Springs, demonstrating the water to be older. Other evidence that Comal Springs water was unaffected significantly by local recharge included: (1) lack of turbidity during and after storms, (2) an inability to dye-trace local 'sinking' to the springs, (3) low coefficients of variation for the different chemical constituents, and (4) its warmer average temperature. Hueco Springs became turbid during storms and showed large chemical changes throughout the year. Cooler average temperature and higher dissolved oxygen for Hueco Springs suggested shallow circulation. Also, a successful dye-trace was performed at Hueco Springs. Faulting has isolated Comal Springs hydrologically from any large sources of local recharge. Thus, a recharge dam nearby will not enhance spring flow. In contrast, much of Hueco Spring's discharge was from local recharge; a close recharge dam could ensure its longevity. (See also W89-04586) (Author's abstract)
W89-04592

RECOMMENDED PROCEDURE FOR EVALUATING THE EFFECTS OF SPILLS OF HAZARDOUS MATERIALS ON GROUND WATER QUALITY IN KARST TERRANES,
National Park Service, Mammoth Cave, KY.
For primary bibliographic entry see Field 5G.
W89-04595

SINKHOLE INVESTIGATION: SOUTH-CENTRAL PENNSYLVANIA,
Buchart-Horn, Inc., York, PA.
M. H. Berry.
IN: Proceedings of the Environmental Problems in Karst Terranes and Their Solutions Conference. National Water Well Association, Dublin, OH. 1986. p 325-344, 10 fig, 8 ref.

Descriptors: *Karst hydrology, *Urban runoff, Water mains, *Sinkholes, *Pennsylvania, *Subsidence, *Engineering geology, Urban areas, Suburban areas, Construction, Stormwater runoff, Infiltration, Limestone.

Two Karst-related subsidences occurred over limestone bedrock in South-Central Pennsylvania. Broken water mains were associated with both. Site methodologies included mapping, soil and rock boring, test pits, structural monitoring, site background studies, eyewitness reports, fracture delineation, and bedrock surface elevation mapping. Features mapped included public utilities, surface drainage patterns, storm water runoff, point source infiltration, and evidence of previous subsidence. The results of these methodologies were combined to define surface and subsurface conditions in the areas near the sinkholes. One subsidence, apparently caused by a broken water main, occurred in a suburban residential area. In addition to right-of-way damage, one residence was impacted and required temporary foundation support. The investigation used conventional test pit excavation to a depth of 25 ft below the basement floor grade. There is a need for the water company to test the integrity of the mains, but there is little possible preventive actions for the municipality. The other subsidence occurred in a turn of the century urban area. Although several residences, sidewalks and a street were impacted, investigation and remediation efforts were hampered by the row house construction, hand-built fieldstone foundations, and damage from several years of on-going subsidence. A part of the investigation was a conventional drilling program covering half of a city block. A poor storm water management system was one of the prime reasons for the past as well as the current subsidence in the area. An integrity check of the water main was recommended and successfully completed. The only remedial action was shown to be a change of storm water management policy by the municipality. (See also W89-04586) (Hammond-PTT)
W89-04602

WATER TRACING USING A SCANNING SPECTROFLUOROMETER FOR DETECTION OF FLUORESCENT DYES,
Missouri Dept. of Natural Resources, Rolla. Div. of Geology and Land Survey.
For primary bibliographic entry see Field 7B.
W89-04606

GROUND WATER FLOW CHARACTERISTICS DESCRIBED BY QUANTITATIVE DYE TRACING IN KARST TERRANE IN THE ELIZABETHTOWN AREA, KENTUCKY,
Geological Survey, Louisville, KY.
For primary bibliographic entry see Field 5B.
W89-04607

AQUIFER PROTECTION PLANNING FOR CRITICAL KARST GROUND WATER SUPPLIES; A COORDINATED LOCAL AND STATE APPROACH FOR KENTUCKY,
Kentucky Natural Resources and Environmental Protection Cabinet, Frankfurt. Div. of Water.
For primary bibliographic entry see Field 5G.
W89-04608

HYDROGEOLOGIC IMPACT ASSESSMENT OF PROPOSED URBANIZATION ATOP A KARST AQUIFER,
NUS Corp., Houston, TX.
For primary bibliographic entry see Field 4C.
W89-04609

INTERLACHEN, FLORIDA; A DESCRIPTION OF THICKLY MANTLED KARST,
GeoLogic Information Systems, Gainesville, FL.
D. V. Arrington, and R. C. Lindquist.
IN: Proceedings of the Environmental Problems in Karst Terranes and Their Solutions Conference. National Water Well Association, Dublin, OH. 1986. p 452-462, 1 fig, 1 tab., 23 ref.

Descriptors: *Karst, *Geomorphology, *Engineering geology, *Hydraulics, *Groundwater, *Sinkholes, *Geohydrology, *Florida, Aquifers, Recharge, Rock properties, Geologic fractures, Precipitation, Remote sensing.

Thickly mantled karst in the peninsula of Florida is characterized by conditions including very permeable, thickened deposits of poorly consolidated sediments, and a soluble rock unit at depth with a pre-existing system of fractures and crevices. High precipitation levels, the dynamics associated with a major aquifer recharge zone, and adequate volume of relatively unsaturated water are also critical factors. This combination of characteristics will determine the dominant vegetation which is readily detected by remote sensing. Sinks will continue to form until the sediment transport routes are blocked and filled to capacity or until the hydrologic system is significantly altered. Potential sinkholes in these areas are probably not detectable by generally accepted geophysical means and beyond a certain probability, cannot be anticipated to any particular degree. Until further research has been completed and the processes involved are better understood, it must be assumed that any development in the sandhill lakes regions of Florida is at significant risk. Unfortunately, lakes created by sinkholes have been considered very desirable recreational homesites for many years. As the population of Florida continues to increase, land owners, construction and insurance industries must continue to avail themselves of information from a wide variety of sources if they are to minimize investment losses in these regions. (See also W89-04586) (Hammond-PTT)
W89-04610

USE OF SPONTANEOUS POTENTIAL IN THE DETECTION OF SUBTERRANEOUS FLOW PATTERNS IN AND AROUND SINKHOLES,
Virginia Military Inst., Lexington. Dept. of Civil Engineering.
R. A. Erchul, and D. K. Butler.
IN: Proceedings of the Environmental Problems in Karst Terranes and Their Solutions Conference. National Water Well Association, Dublin, OH. 1986. p 465-86, 5 fig, 6 tab, 10 ref.

Descriptors: *Groundwater movement, *Karst hydrology, *Sinkholes, *Electric potential, *Geophysics, *Virginia, Flow pattern, Subsurface drainage, Precipitation, Temperature effects.

Spontaneous Potential was effectively used in the detection of surface and subsurface drainage around a sinkhole. The same Spontaneous Potential technique was also able to track a subsurface drainage path for more than 600 ft from one sinkhole into another sinkhole. Confirmation of the Spontaneous Potential data was obtained by visual observation, electrical resistivity measurements and geological studies. The use of this geophysical technique was evaluated in and around sinkholes in a karst area of west central Virginia. The Spontaneous Potential electrode configuration consisted of a double ring of electrodes circumferentially located around each sinkhole. Two reference electrodes were used in taking Spontaneous Potential measurements. One reference electrode was located outside the rings of electrodes and the other was located in the center of one of the sinkholes. Once a major drainage path around the sinkhole was detected an array of electrodes was used to track the drainage path. Although Spontaneous Potential data varied significantly for individual electrodes during the six month testing period, the relative values between electrodes were consistent. This was also true if the position of the reference electrode was changed. It appeared that changes in precipitation and temperature had the greatest effect on the variation of Spontaneous Potential data over the testing period. (See also W89-04586) (Author's abstract)
W89-04611

ASSESSMENT BY ELECTRICAL RESISTIVITY METHODS OF POTENTIAL GEOLOGICAL HAZARDS IN KARSTIC TERRANES,
Florida Univ., Gainesville. Dept. of Geology.
For primary bibliographic entry see Field 8E.
W89-04612

USE OF GROUND PENETRATING RADAR TECHNIQUES TO AID IN THE DESIGN OF ON-SITE DISPOSAL SYSTEMS,
University of Central Florida, Orlando.
For primary bibliographic entry see Field 7B.
W89-04613

EFFECTS OF BRINE ON THE CHEMICAL QUALITY OF WATER IN PARTS OF CREEK, LINCOLN, OKFUSKEE, PAYNE, POTTAWATOMIE, AND SEMINOLE COUNTIES, OKLAHOMA,
Geological Survey, Norman, OK.
For primary bibliographic entry see Field 5B.
W89-04614

GROUNDWATER LEVELS IN NEBRASKA, 1984,
Geological Survey, Lincoln, NE. Water Resources Div.
M. J. Ellis, and D. T. Pederson.
Nebraska Water Survey Paper Number 59, June 1984. 67p, 25 fig, 31 ref.

Descriptors: *Water resources data, *Nebraska, *Groundwater level, *Data collections, Maps, Hydrographs, Comparison studies, Seasonal variation, Precipitation, Groundwater depletion.

This 31st annual report on Nebraska's groundwater levels, summarizes the water level changes from 1983 to 1984 and shows, through the use of maps of the entire state and of the major areas of the state, where significant changes from estimated predevelopment levels have occurred. Water levels were higher in fall 1984 than in fall 1983 in over 70% of the observation wells measured; a continuation of a general statewide trend since 1980-1. In 1984, levels were less than 3 ft higher in most wells but were 4 to more than 10 ft higher in some. The greatest water-level rises were in the east-central and northeastern parts of the state where precipitation was normal to above normal during the growing season. Levels mostly declined in the south central, southwest, and Panhandle, reflecting large irrigation withdrawals necessitated by below-normal precipitation. Before development most groundwater systems in a state of near equilibrium natural equilibrium of groundwater systems has been altered by (1) increased discharge from irrigation wells, (2) recharge from infiltration of surface water applied to irrigated crops, (3) recharge resulting from deep percolation of seepage from irrigation storage and distribution systems, (4) discharge to man-made drains, and (5) changes in land use that affect the amount of recharge an aquifer receives. In many parts of the state, water-level fluctuations resulting from natural conditions may be either masked or accentuated by water-level fluctuations resulting from human activities. Because data points on which the maps are based are not evenly distributed, some areas may not be delineated as precisely as others. (See also W89-04616) (Lantz-PTT)
W89-04615

GROUNDWATER LEVELS IN NEBRASKA, 1985,
Geological Survey, Lincoln, NE. Water Resources Div.
M. J. Ellis, and D. T. Pederson.
Nebraska Water Survey Paper Number 61, July 1986. 65p, 17 fig, 32 ref.

Descriptors: *Water resources data, *Nebraska, *Groundwater level, *Data collections, Maps, Hydrographs, Comparison studies, Seasonal variation, Precipitation, Groundwater depletion.

This 32nd annual report on Nebraska's groundwater levels, summarizes the water level changes from 1984 to 1985 and the significant long-term changes in water levels that have resulted from human activities. These water level changes are shown through the use of maps and hydrographs. Although water levels were higher in fall 1985 than in fall 1984 in about 70% of the observation wells measured, distinct differences in water-level changes were observed in different parts of the state. In the west south-central and central parts of the state, where precipitation was above normal during most of the growing season, most water levels were 1 - 2 ft higher and in a few wells 3 - 9 ft higher. Precipitation was below normal in the southwest, east north-central, and panhandle during most of the growing season, and most water levels were less than 1 ft lower. In Nebraska, where use of water for irrigation causes the most significant water-level fluctuations, most observation wells are measured in the spring and in the late fall. Spring measurements are useful in determining amounts of groundwater in storage each year before irrigation starts. Fall measurements are useful in evaluating the effects of annual water use for irrigation and for delineating problem areas or potential problem areas more accurately. Fall measurements, therefore, are used in this report for documenting both the annual and the long-term changes in water levels. In the summaries of water-level changes in the East South-Central and the Southwest Divisions, changes between estimated predevelopement water levels and spring 1985 levels are also described because groundwater control areas are located in these divisions. (See also W89-04615) (Lantz-PTT)
W89-04616

APPRAISAL OF WATER IN BEDROCK AQUIFERS, NORTHERN CASCADE COUNTY, MONTANA,
Montana Bureau of Mines and Geology, Butte.
K. R. Wilke.
Montana Bureau of Mines and Geology Memoir 54, 1983. 22p, 3 fig, 5 tab, 2 sheets, 31 ref, append.

Descriptors: *Water resources data, *Data collections, *Montana, *Aquifers, *Groundwater quality, *Bedrock, Mixing, Dissolved solids, Chemical analysis, Minerals.

Suburban residential expansion of the city of Great Falls has resulted in an increased demand on water supplies from bedrock aquifers in northern Cascade County. Water levels in the Madison-Swift aquifer and all overlying aquifers, including the Quaternary deposits aquifer, reflect unconfined (water-table) conditions in the Great Falls vicinity. Significant vertical interaquifer mixing of water, as well as surface water-groundwater interchange, probably occurs in the central part of the study area. The quality of water varies among aquifers throughout the study area. The ranges of dissolved solids concentrations determined by chemical analysis are: Madison-Swift aquifer, about 520 to 1,570 mg/L; Morrison Formation, 908 to 1,480 mg/L; Kootenai Formation, 558 to 1,550 mg/L; Colorado Group, 2,690 and 2,740 mg/L (two samples); and unconsolidated Quaternary deposits, 383 to 2,060 mg/L. The chemical quality of water from the Colorado Group in the western third of the area generally is more mineralized than water from aquifers in the rest of the area. Specific conductance of water from eight wells completed in the Colorado Group averages 4,440 micromhos/cm at 25 C. (Lantz-PTT)
W89-04617

HYDROGEOLOGY AND GEOCHEMISTRY OF THE UNCONFINED AQUIFER, WEST-CENTRAL AND SOUTHWESTERN DELAWARE,
Delaware Geological Survey, Newark.
J. M. Denver.
Delaware Geological Survey Report of Investigations No. 41, June 1986. 100p, 24 fig, 11 tab, 39 ref, 2 append.

Descriptors: *Water resources data, *Geohydrology, *Aquifers, *Geochemistry, *Water pollution sources, *Groundwater quality, *Delaware, Chemical analysis, Land use, Nitrates, Agriculture, Fertilizers, Alkalinity.

The unconfined aquifer is the major source of water supply in west-central and southwestern Delaware. The aquifer, which is composed of quartz sand, gravel, clay, and silt, ranges from land surface to about 20 feet below land surface. Analyses of water from wells distributed throughout the area were used to study processes controlling the chemical quality of the water in the unconfined aquifer. Concentrations of the major ions (sodium and bicarbonate) in the groundwater range from 4.4 to 10.0 mg/L and from 5.8 to 52.4 mg/L, respectively. Ferrous iron may also be a major ion where the aquifer has a reducing environment. Concentrations of chemical constituents in the unconfined aquifer are naturally low and specific conductance of the water sampled was < 100 microsiemens/cm at 25 C. Chemistry of water in the unconfined aquifer is closely related to land use. The permeability and drainage of soil which control redox potential near the surface of the aquifer also influence water chemistry. Most of the soils are well drained so that chemical applied to or near the land surface are carried rapidly into the aquifer. Elevated concentration of nitrate is the major water quality problem in the oxygenated parts of the aquifer. Agricultural applications of inorganic fertilizer and manure are the most widespread sources of nitrate. Leachate from animal confinement and domestic septic systems are other sources of nitrate in the water. Two characteristic trends in the chemistry of water in the unconfined aquifer are: (1) increasing alkalinity with increasing specific conductance associated with oxygenated natural water and reduced water; and (2) consistently low alkalinity (< 10 mg/L) over a wide range of specific conductance associated with oxygenated water influenced by land use. (Lantz-PTT)
W89-04618

HYDROLOGY OF THE MANOKIN, OCEAN CITY, AND POCOMOKE AQUIFERS OF SOUTHEASTERN DELAWARE,
Delaware Geological Survey, Newark.
A. L. Hodges.
Delaware Geological Survey Report of Investigations No. 38, January 1984. 60p, 17 fig, 9 tab, 40 ref, 2 append.

Descriptors: *Aquifers, *Hydrologic studies, *Delaware, *Water resources, Groundwater budget, Groundwater level, Groundwater recharge, Model studies, Hydrologic models, Water supply, Groundwater management.

Population and accompanying water use are expected to increase by 34% in southeastern Delaware between 1975 and 2000. To assess the capability of the aquifers in that area to supply the required amount of groundwater, a study of those aquifers was started in 1976. Interpretation of geologic sections developed from drilling and geophysical data showed that the confining beds between the Manokin, Ocean City, and Pocomoke aquifers of Neogene age are thin and discontinuous in some parts of the area. Hydrographs of water levels in the aquifers show differential drawdown during periods of heavy pumping, but levels return to a common altitude during unstressed periods. A digital model of this confined system was developed which included the overlying unconfined aquifer (Pleistocene age), the underlying confined aquifer (middle Miocene age), and the confining beds between these aquifers. The model was calibrated under both steady-state and transient (1976-1979) conditions using historical pumpage and water level data. The unconfined aquifer was modeled as a constant head source of recharge to the underlying Manokin, Ocean City, and Pocomoke aquifers. Where the confining bed between these aquifers is very thin or absent, water levels in the Manokin, Ocean City, and Pocomoke system approach the constant-head value specified for the unconfined aquifer. This precluded matching simulated water levels to observed water levels in these subcrop areas. Therefore, the model is considered to be untested and uncalibrated where the two aquifers are connected. The calibrated model was used to simulate the effect that increased pumpage would have on water levels in the Neogene age sands for the period 1980-2004. A maximum decline in water level of 2.60 feet resulting from projected increases in pumpage during this period is predicted to occur at Lewes. The decline would induce movement of saltwater toward the Lewes well field beginning about 1989. The model suggests that there is little potential for upward movement of water through the underlying confining bed (St. Marys Formation) from deeper units as a result of projected pumpage in the Manokin, Ocean City, and Pocomoke aquifers. (Author's abstract)
W89-04619

SINKHOLES IN FLORIDA: AN INTRODUCTION,
Florida Sinkhole Research Inst., Orlando.
B. F. Beck, and W. C. Sinclair.
Florida Sinkhole Research Inst. Report No. 85-86-4, 1986. 16p.

Descriptors: *Sinkholes, *Geohydrology, *Sinks, *Florida, *Karst hydrology, *Florida, Groundwater, Drainage, Groundwater movement, Limestone.

Florida's landscape is reknown for its myriad of lakes and springs. Many of the smaller lakes are actually ancient sinkholes. Over thousands of

years, erosion has changed the original steep-sided funnel shape into a broad, shallow lake by cutting back the sides and filling the middle. Both sinkholes and springs are a product of a certain peculiarity of the geology of northern and central Florida. The landscape of much of Florida is a karst terrain: a land surface produced by water dissolving the rock, rather than wearing it away. In a karst terrain, rain water generally sinks into the ground rather than running off in streams and rivers. Rather than being drained by a system of creeks and streams that join together to feed a river, a karst terrain is marked by a series of funnel-shaped basins that drain rainwater underground: sinkholes. However, sinkholes are only one facet of such a landscape. A karst terrain may be likened to a giant plumbing network under the ground. Water flows down into this network through numerous sinkholes and smaller, still-developing cracks in the limestone. Under the ground, within the limestone, the water reaches a zone where all the cracks and voids are already filled with water. Here it flows laterally through caves, enlarged cracks, and irregular pores, created by thousands of years of limestone dissolution. Where the limestone layers are exposed at a lower level, water may emerge from this flow system as springs. The solution process and how it produces sinkholes is described in more detail in Part I of this pamphlet, and how these features interact with man and his activities is the subject of Part II. (See W89-04621 thru W89-04622) (Lantz-PTT)
W89-04620

PART I: WHAT ARE SINKHOLES AND HOW AND WHERE DO THEY FORM,
Geological Survey, Tampa, FL.
W. C. Sinclair.
IN: Sinkholes in Florida: An Introduction. Florida Sinkhole Research Inst. Report No. 85-86-4, 1986. p 1-9, 6 fig, 1 tab.

Descriptors: *Sinks, *Karst hydrology, *Florida, *Sinkholes, *Geohydrology, Erosion, Limestone, Chemical reactions, Groundwater movement, Acidic water.

Sinkholes are a geologic hazard that occur in areas underlain by soluble bedrock such as limestone. Sinkholes are part of the natural process of erosion in limestone terrain. Just as rivers constantly erode the land surface and carry away soil and sediment a particle at a time, so also is limestone carried slowly away. But the limestone is carried off in chemical solution, an ion at a time, in water that moves through cavities and conduits in the underlying rock. Sinkholes occur in a variety of shapes from steep-walled 'natural wells' to funnel-shaped or bowl-shaped depressions. Shape or form generally is not an indication of their mode of occurrence. Sinkholes, however, can be classified by their manner of origin as either solution sinkholes or collapse sinkholes. The major types of sinkholes are: (1) limestone solution; (2) limestone collapse; (3) cover subsidence; and (4) cover collapse. The ultimate cause of collapse or subsidence that forms all sinkholes is solution of limestone by acidic water. Rainfall percolating through soils reacts with decaying vegetation and absorbs carbon dioxide. As a result, the water becomes a weak carbonic acid solution. The acidic water slowly dissolves limestone as it moves through pore spaces and fractures--enlarging the openings and developing a network of conduits and interconnected cavities that are capable of accepting increasingly larger volumes of water. (See also W89-04620) (Lantz-PTT)
W89-04621

PART II: SINKHOLES AND MAN,
Florida Sinkhole Research Inst., Orlando.
B. F. Beck.
IN: Sinkholes in Florida: An Introduction. Florida Sinkhole Research Inst. Report No. 85-86-4, 1986. p 10-16, 4 fig.

Descriptors: *Karst hydrology, *Florida, *Sinkholes, *Sinks, *Geohydrology, *Regional development, Construction, Roads, Waste storage.

The formation of sinkholes is not simply a geological phenomenon, it may also be a serious hazard to man. When sinkholes develop in urban or suburban areas they affect man's environment. When they develop under homes and office buildings, they may have catastrophic impact. Sinkholes under highways necessitate expensive repairs and may cause accidents. Sinkholes which develop in waste storage ponds may cause serious groundwater pollution. Man's activities may actually trigger sinkhole development. They include concentrated withdrawal of water from a limestone aquifer thus lowering the groundwater pressure; raising the level of shallow groundwater or artificially pondering surface water; construction activities that intercept drainage from a large area and concentrate the infiltration of this drainage at one place; as well as construction of new water wells. In most cases it can be related to some type of activity which increases both the infiltration into the limestone aquifer and the accompanying down washing of overlying sediment. (See also W89-04620) (Lantz-PTT)
W89-04622

HYDROGEOLOGY OF THE GORDON AQUIFER SYSTEM OF EAST-CENTRAL GEORGIA,
Geological Survey, Atlanta, GA.
R. Brooks, J. S. Clarke, and R. E. Faye.
Georgia Geologic Survey Information Circular 75, 1985. 41p, 18 fig, 2 tab, 2 plates, 67 ref, 2 append.

Descriptors: *Water resources data, *Geohydrology, *Gordon Aquifer, Georgia, Aquifers, Groundwater budget, Water use, Groundwater recharge, Precipitation, Calcium bicarbonate, Water quality, Groundwater quality.

Interlayered sand, silt, and clay of middle Eocene to late Paleocene age in east-central Georgia form the Gordon aquifer system which ranges in thickness from about 20 to 180 ft. Estimated transmissivities range from 620 to 13,000 sq ft/day. During 1980, approximately 24 million gpd (gallons per day) was withdrawn from the Gordon aquifer system, of which about 70% was used for irrigation. Water levels in the aquifer throughout the study area generally showed little change during 1934-68; however, during 1969-81, local declines as great as 33 ft have occurred in areas of increased irrigation or large scale municipal and industrial pumping. The Gordon aquifer system is recharged by precipitation in the outcrop area and in interstream drainage divides in and near the outcrop area, and by leakage through adjacent confining units. Discharge from the aquifer occurs predominantly as flow into streams or as leakage into underlying and overlying units. Water from the Gordon aquifer system is generally a calcium bicarbonate type that ranges from soft to hard, and in most areas has constituent concentrations that are within the Georgia Environmental Protection Division recommended drinking water standards. (Author's abstract)
W89-04623

HYDROGEOLOGY OF THE DUBLIN AND MIDVILLE AQUIFER SYSTEMS OF EAST-CENTRAL GEORGIA,
Geological Survey, Atlanta, GA.
J. S. Clarke, R. Brooks, and R. E. Faye.
Georgia Geologic Survey Information Circular 74, 1985. 62p, 28 fig, 60 ref, 2 append.

Descriptors: *Water resources data, *Geohydrology, *Midville Aquifer, *Dublin Aquifer, *Georgia, *Aquifers, Groundwater budget, Water use, Groundwater recharge, Precipitation, Calcium bicarbonate, Water quality, Groundwater quality, Permeability coefficient, Iron, Transmissivity.

During 1980, an estimated 121 million gallons of water per day was pumped in a 26-county area in east-central Georgia from sand aquifers of Paleocene and Late Cretaceous age. Maximum withdrawals were at the kaolin mining and processing centers in Twiggs, Wilkinson, and Washington Counties, where water levels have declined as much as 50 ft since 1944-50. In the southern two-thirds of the study area, water levels have shown little, if any, change. Declining water levels and increasing competition for groundwater have caused concern over the adequacy of groundwater supplies. This report defines the areal extent and describes the geohydrology of the Paleocene-Upper Cretaceous aquifers of east-central Georgia, and evaluates the effects of man on the groundwater flow system. Geohydrologic data from four test wells indicate that the aquifers consist of alternating layers of sand and clay that are largely of deltaic origin. In the northern third of the study area, the confining unit between the Dublin and Midville aquifer systems is absent and the aquifer systems combine to form the Dublin-Midville aquifer system. The aquifer systems range in thickness from 80 to 645 ft and their transmissivities range from 800 to 39,000 sq ft/day. The hydraulic conductivity ranges from 15 to 530 ft/day. Wells yield as much as 3,400 gpm (gallons per minute). Chemical analyses of water from 49 wells indicate that water from both aquifer systems is of good quality except in the central part of the study area, where iron concentrations are as high as 6,700 micrograms/L and exceed the 300 micrograms/L recommended limit for drinking water. The principal recharge to the aquifer systems is from precipitation that occurs within and adjacent to the outcrop areas. The principal discharge is to streams in the outcrop area. (Author's abstract)
W89-04624

GEOLOGY FOR PLANNING IN BOONE AND WINNEBAGO COUNTIES,
Illinois State Geological Survey Div., Champaign.
R. C. Berg, J. P. Kempton, and A. N. Stecyk.
Illinois State Geological Survey Division Circular 531, 1984. 69p, 21 fig, 7 tab, 3 plates, 94 ref, append.

Descriptors: *Geologic data, *Geohydrology, *Aquifers, *Boone County, *Winnebago County, *Illinois, Path of pollutants, Groundwater quality, Water pollution sources, Waste disposal, Sand, Gravel, Groundwater movement.

This report provides comprehensive information on the geology, geohydrology, and mineral resources of Boone and Winnebago Counties for use in resource-based land-use planning and development. Data on the composition, thickness, and regional distribution of glacial drift and bedrock materials were used to construct maps of: geologic materials to a depth of 20 ft; bedrock topography; drift thickness; major terrains; and glacial drift aquifers. Because contamination of aquifers is a serious concern in some areas of the two counties, a major focus of this study is on interpreting data critical to the selection of suitable areas for municipal waste disposal and prevention of contamination from existing municipal landfills and septic systems. Interpretive maps accompanying the text: (1) rate geological sequences on their capacity to protect aquifers and surface water from contamination by land burial of municipal wastes, septic system disposal, and surface spreading of wastes and agricultural chemicals; (2) geologic sequences on their suitability for general construction; and (3) delineate resources of sand, gravel, peat, and dolomite. Areas in which aquifer contamination from waste disposal and other land-use practices is most likely to occur are those in which sand and gravel and/or permeable creviced bedrock are at or near the surface. Areas having the lowest contamination potential are underlain by thick (20 ft or more) deposits of fine-grained glacial till. Areas most favorable for general construction are well-drained locations in major river valleys and terrace outwash plains; areas least favorable for construction are scattered throughout both counties on poorly drained land having low bearing capacities and on uplands and slopes in northwestern Winnebago County where the drift is thin over the bedrock. Extensive deposits of sand and gravel occur in the major bedrock valleys. Dolomite deposits underlie all the uplands of Winnebago County and most of Boone County, but extraction costs are prohibitive where overburden is thick. High-grade dolomite with relatively thin overburden is found in eastern Winnebago County and southwestern Boone County. (Author's abstract)
W89-04626

ELECTRIC EARTH RESISTIVITY SURVEY OF THE MACON-TAYLORVILLE RIDGED-DRIFT AQUIFER,
Illinois State Geological Survey Div., Champaign.
P. C. Heigold, V. L. Poole, K. Cartwright, and R. H. Gilkeson.
Illinois State Geological Survey Circular 533, 1985. 23p, 10 fig, 11 ref, append.

Descriptors: *Glacial aquifers, *Glacial drift, *Aquifers, *Resistivity, *Illinois, Geochemistry, Permeability coefficient, Electric properties, Groundwater level, Pump tests, Geophysics.

Between the towns of Macon and Taylorville in central Illinois lies a ridge that is part of a system of ridges and knolls largely composed of sand and gravel. This ridge contains an important aquifer. An extensive electrical earth resistivity survey was conducted over the ridged-drift aquifer. Inversion of the resistivity data provided information concerning aquifer thickness and aquifer resistivity. This information, along with pump test data along the aquifer, indicated a direct and geometric relationship between aquifer resistivity and hydraulic conductivity. As a result, it was possible to better define the boundaries and water-producing capabilities of the aquifer. (Author's abstract)
W89-04627

HYDROGEOLOGY OF THE UPPER CHESAPEAKE BAY AREA, MARYLAND, WITH EMPHASIS ON AQUIFERS IN THE POTOMAC GROUP,
Maryland Geological Survey, Baltimore.
E. G. Otton, and R. J. Mandle.
Maryland Geological Survey Report of Investigations No. 39, 1984. 62p, 19 fig, 11 tab, 33 ref.

Descriptors: *Water resources data, *Maryland, *Geohydrology, *Chesapeake Bay, *Aquifers, Hydrologic studies, Test wells, Boreholes, Transmissivity, Sand, Geophysics, Electrical properties, Dissolved solids, Chlorides, Chemical analysis, Groundwater recharge.

To gain a better understanding of the groundwater hydrology of aquifers in the Potomac Group on Maryland's Eastern Shore, six test holes were drilled through the Coastal Plain deposits in Cecil and Kent Counties. A similar test hole was drilled in Queen Annes County near Chestertown, Maryland, before the beginning of this study. At each test site the Coastal Plain sediments were penetrated to crystalline basement rock, the altitude of which ranges from 1,121 feet below sea level at Stillpond Neck to 2,059 feet below sea level at Massey, Maryland. Thickness of the Potomac Group ranges from 1,038 feet at Stillpond Neck to 1,538 feet at Massey. Sand-percentage and total sand-thickness maps show that the sand percentage of the Potomac Group decreases with distance from the Fall Line, whereas total sand thickness increases. Transmissivity and sand-unit thickness and sand percentage seem to be directly related. Most areas of reported high transmissivity are nearer to the Fall Line, where sand percentages are highest and individual sand units are generally thickest. Analyses of multi-point electric logs suggest that brackish water is present in the Potomac Group at the Coast Guard Station on Stillpond Neck and the towns of Fairlee, Kennedyville, and Massey. Subsequent chemical analyses from Stillpond Neck and Fairlee showed chloride and dissolved solids concentrations of 1,000 and 1,800 mg/L, and 950 and 1,990 mg/L, respectively. The relatively high chloride concentration in the aquifers of the Potomac Group is attributed to sea water intrusion. A geohydrologic cross-section shows that water enters the aquifers in the Potomac Group west of Chesapeake Bay and discharges to the Bay and its saline estuaries. There does not seem to be a significant component of flow under Chesapeake Bay to the Delmarva Peninsula, except perhaps in the deepest aquifers. On the Delmarva Peninsula, water largely recharges the aquifers of the Potomac Group through overlying formations on the upper end of the Peninsula. It then appears to move laterally through the aquifers, then upward through overlying formations and discharges to the Chesapeake Bay and Delaware Bay. (Author's abstract)
W89-04628

EVALUATION OF THE WATER-SUPPLY POTENTIAL OF AQUIFERS IN THE POTOMAC GROUP OF ANNE ARUNDEL COUNTY, MARYLAND,
Maryland Geological Survey, Baltimore.
For primary bibliographic entry see Field 4B.
W89-04629

GROUND-WATER AND SURFACE-WATER DATA FOR FREDERICK COUNTY, MARYLAND,
Maryland Geological Survey, Baltimore.
For primary bibliographic entry see Field 7C.
W89-04632

GROUNDWATER RESOURCES OF THE BERWICK-BLOOMSBURG-DANVILLE AREA, EAST-CENTRAL PENNSYLVANIA,
Geological Survey, Harrisburg, PA. Water Resources Div.
J. H. Williams, and D. A. Eckhardt.
Pennsylvania Geological Survey Water Resources Report 61, 1987. 76p, 19 fig, 24 tab, 1 plate, 23 ref.

Descriptors: *Water resources data, *Geohydrology, *Groundwater budget, *Groundwater quality, *Water supply, Pennsylvania, Geochemistry, Hydrologic studies, Aquifers, Groundwater quality, Calcium.

The area of investigation is in the valley of the North Branch Susquehanna River and surrounding uplands, and occupying parts of Columbia, Luzerne, Montour, and Northumberland Counties in east-central Pennsylvania. The bedrock underlying the area is of Silurian, Devonian, and Mississippian age and includes gradational sequences of noncarbonate and carbonate lithologies. The bedrock aquifers have a strong directional permeability along bedding strike. The development of secondary permeability is largely controlled by the amount of calcareous material in an aquifer, and the carbonate rock of the Keyser and Tonoloway Formations is, accordingly, the most productive bedrock aquifer. The most extensive stratified deposit is the sand and gravel outwash of late Wisconsinan age that occupies the Susquehanna River and Fishing Creek valleys. Because of its high primary permeability, the glacial-outwash aquifer has a great capacity to receive, store, and transmit water. Well yields for the aquifers were estimated from data on specific capacity, depth to water-bearing zones, and water levels. The median estimated well yields for the aquifers range from 5 gpm (gallons/minute) for the Trimmers Rock Formation to 190 gpm for glacial outwash. The results of 139 chemical analyses show that groundwater chiefly is the calcium bicarbonate type. Most groundwater tapped by wells is usable for domestic supply and human consumption, although hardness, iron, manganese, and hydrogen sulfide gas that exceed maximum recommended concentrations may cause problems locally. Water from aquifers containing carbonate rock generally is hard to very hard. Iron concentrations that exceed 300 micrograms/L were observed in 46% of the wells sampled and manganese concentrations that exceed 50 micrograms/L were observed in 40% of the wells. Hydrogen sulfide gas was detected in 9% of the wells sampled. Problems with concentrations that exceed recommended limits for these constituents are more common in groundwater from the Devonian rocks that contain black shale, although excess manganese also is a common problem in the glacial-outwash aquifer. (Lantz-PTT)
W89-04635

GROUNDWATER LEVELS IN NEBRASKA 1986,
Geological Survey, Lincoln, NE. Water Resources Div.
M. J. Ellis, and V. H. Dreeszen.
Nebraska Water Survey Paper Number 62, July 1987. 68p, 24 fig, 2 tab, 3 ref.

Descriptors: *Water resources data, *Data collections, *Groundwater level, *Nebraska, *Hydrologic studies, Hydrologic data, Hydrographs, Precipitation, Groundwater depletion, Water level.

In 1930 the Conservation and Survey Division of the University of Nebraska and the U.S. Geological Survey began a cooperative water level measurement program to observe and document, on a continuing basis, the fluctuations in groundwater levels throughout Nebraska. This program includes evaluation of the adequacy and accuracy of the water level information collected and provides a means for its storage, retrieval, and dissemination in a readily understandable format. This 33rd annual report on Nebraska's groundwater levels, summarizes the water level changes from 1986 to 1987 and the significant historic changes in water levels, shown through the use of maps and hydrographs. Thirty-eight agencies collected water-level measurements that serve as basic data for this report. Measurements were made in more than 3,600 observation wells. Water levels rose in more than two-thirds of Nebraska's observation wells in 1986, however, water levels averaged slightly less than 1 foot lower last year in the Southwest Division. Annual precipitation during 1986 was above normal in all of Nebraska's climate divisions except the Southwest and South-Central Divisions. Nebraska's largest use of groundwater during 1986 was that pumped by the state's registered irrigation wells. Estimated at 5.8 million acre-feet, this amount of groundwater was about 14 times the amount pumped for domestic, livestock, municipal, industrial, and other uses. During 1986, however, only 97 new irrigation wells were drilled in Nebraska. The last year in which fewer new irrigation wells were drilled was 1934. (Lantz-PTT)
W89-04636

POTENTIOMETRIC SURFACE OF THE UPPER FLORIDAN AQUIFER IN GEORGIA, MAY 1985, AND WATER-LEVEL TRENDS, 1980-85,
Georgia Dept. of Natural Resources, Atlanta.
J. S. Clarke.
Georgia Geologic Survey Hydrologic Atlas 16, 1987. 1p, 14 fig, 1 map, 15 ref.

Descriptors: *Water resources data, *Georgia, *Maps, *Groundwater level, *Floridan Aquifer, *Data collections, Groundwater budget, Potentiometry, Groundwater recession, Maps, Water level, Alabama, South Carolina, Florida, Aquifers.

The Floridan aquifer system (formerly the principal artesian aquifer) is the main source of groundwater in the Coastal Plain of Georgia. About 600 Mgal/d (million gallons per day) is withdrawn from the upper part of the aquifer system (Upper Floridan Aquifer) in Georgia, mostly for industrial use and for irrigation. As a result of this pumping, large cones of depression in the potentiometric surface have formed at Savannah, Brunswick, Jesup, and St. Marys, Ga.-Fernandina Beach, Fla. Declining water levels in these and other areas have caused concern over protection of the groundwater resource. To monitor water level fluctuations and trends in the Floridan and in other aquifers, the U.S. Geological Survey, in cooperation with the Georgia Department of Natural Resources, Environmental Protection division, Geologic Survey Branch, and other State and local agencies, operates a network of approximately 1,700 water level monitoring wells, including 149 equipped with continuous water level recorders. This report depicts and describes the potentiometric surface of the Upper Floridan aquifer in Georgia for May 1985. The potentiometric surface, which represents the altitude at which water would have stood in tightly cased wells that tap the aquifer, was constructed from water level and pressure measurements made in more than 1,000 wells in Georgia and adjacent parts of Alabama, South Carolina, and Florida during May 13-24, 1985. The report also discusses water level fluctuations and trends in the Upper Floridan aquifer in different parts of the State for 1980-85. (Lantz-PTT)
W89-04638

STRATIGRAPHY, HYDROGEOLOGY, AND WATER CHEMISTRY OF THE CRETACEOUS AQUIFERS OF THE WALDORF/LA PLATA AREA, CHARLES COUNTY, MARYLAND,
Maryland Geological Survey, Baltimore.
J. M. Wilson.
Maryland Geological Survey Open File Report No. 86-02-2, 1986. 66p, 9 fig, 5 tab, 1 plate, 39 ref, 5 append.

Descriptors: *Charles County, *Water resources data, *Data collections, *Geohydrology, *Water quality, *Aquifers, *Stratigraphy, *Maryland, Wells, Hydrologic studies, Transmissivity, Permeability coefficient, Groundwater quality, Hydrogen ion concentration, Dissolved solids, Storage coefficient, Hydraulic conductivity.

Test well Ch-Bf 146 was drilled to 1,650 ft below land surface to explore and evaluate the Patapsco Formation aquifers deeper than 1,000 ft in the Waldorf/La Plata area of Charles County, Maryland. The test hole penetrated two major aquifer systems above a depth of 1,000 ft and another major aquifer system and aquifer below 1,000 ft. The deepest aquifer system found in the test drilling, the Lower Patapsco aquifer system, is comprised of a group of sands which lie between 1,140 ft and the base of the Patapsco Formation at 1,417 ft. The Waldorf aquifer system, overlies the Upper Patapsco aquifer system and includes sands in the Waldorf/La Plata area that are referred to as the 'Magothy aquifer' by other. At the test well site, the Waldorf aquifer system consists solely of sands in the Magothy and Monmouth Formations. The three major aquifer systems and the Middle Patapsco aquifer are correlative along the regional strike for at least 10 miles in the Waldorf/La Plata area. Correlations of geophysical logs indicate that individual sands 15 to 25 ft thick can be traced between wells. Geophysical log correlations also indicate that, at some well sites, the Waldorf aquifer system and the Upper Patapsco aquifer system are in sand-on-sand contact and function as one major hydrologic system at these sites. A production well (Ch-Bf 147) was drilled at the site of the test well (Ch-Bf 146). The initial static water level of these aquifers was 9.8 ft below sea level. Evaluation of the 24-hr pumping test of Ch-Bf 147 resulted in a transmissivity of 14,000 gpd/ft (gallons per day per foot) for the first 2 hours of the test and 7,300 gpd/ft for the remainder of the test. The decrease of 6,700 gpd/ft in the transmissivity indicates that the well's expanding cone of depression intersected a transmissivity boundary after 2 hours of pumping. The Patapsco sands tested in Ch-Bf 147 have a storage coefficient of 0.0016. The hydraulic conductivity of the producing sands in Ch-Bf 147 is 127 gpd/sq ft. The quality of groundwater from the Lower Patapsco aquifer system and the Middle Patapsco aquifer is suitable for most purposes. The water is nearly neutral (pH = 7.4), low in dissolved solids (about 200 mg/L), low in specific conductance, slightly warm (22 C), very soft, naturally fluoridated, and moderately high in dissolved silica. (Lantz-PTT)
W89-04642

APPLICATION OF A NUMERICAL GROUNDWATER FLOW MODEL TO THE MUD LAKE AREA IN SOUTHEASTERN IDAHO,
Idaho Water and Energy Resources Research Inst., Moscow.
G. S. Johnson, C. E. Brockway, and S. P. Luttrell.
Idaho Water Resources Research Institute Technical Completion Report, December 1984. 60p, 27 fig, 2 tab, 25 ref. Contract 14-08-0001-A-0016.

Descriptors: *Groundwater movement, *Model studies, Idaho, Mathematical models, Aquifers, Groundwater budget, Groundwater recharge, Transmissivity, Hydrologic studies, Simulation analysis, Groundwater management, Irrigation.

The regional Snake Plain aquifer is the primary source of groundwater throughout the eastern Snake River Plain including the Mud Lake area. Groundwater flow from mountain valleys to the north of the Mud Lake area annually supply about 247,000 acre-ft of recharge to the regional aquifer. Groundwater exits the study area in a southwesterly direction as part of the Snake River Plain regional groundwater flow system. A local, overlying groundwater system in the alluvium east of Mud Lake annually leaks about 113,000 acre-ft of recharge to the regional aquifer. About 143,000 acres of agricultural land present within the study are irrigated from local and regional groundwater resources and from surface water. A numerical groundwater flow model was calibrated to determine variations in transmissivity and storage coefficient. Calibration was based on hydrologic data collected from April, 1980 through March, 1981; included were several determinations of the water table based on depth to water measurements. A band of steep hydraulic gradients transects the study area and coincides with a band of relatively low transmissivities, < 40,000 sq ft/d. Transmissivities in the remainder of the area generally exceed 1,000,000 sq ft/d. Refined calibration of the storage coefficient was not possible in some areas due to little change in water levels during the calibration period. A 20-year simulation of current irrigation practices under normal hydrologic conditions predicts a general decline in groundwater levels. Simulation of a hypothetical increase in water use for irrigation predicts an additional decline of as much as 80 feet. Simulation of 186,000 acre-ft of artificial recharge biennially results in a groundwater mound reaching a maximum height of 40 ft. Such a rise could cause temporary flooding of depressions in the vicinity of the recharge. (Author's abstract)
W89-04644

WATER RESOURCES OF THE BIG HOLE BASIN, SOUTHWESTERN MONTANA,
Montana Bureau of Mines and Geology, Butte.
For primary bibliographic entry see Field 2E.
W89-04645

WATER RESOURCES OF LAKE CREEK VALLEY, NORTHWESTERN MONTANA,
Montana Bureau of Mines and Geology, Butte.
For primary bibliographic entry see Field 2E.
W89-04646

RECORDS OF GROUND-WATER RECHARGE, DISCHARGE, WATER LEVELS, AND CHEMICAL QUALITY OF WATER FOR THE EDWARDS AQUIFER IN THE SAN ANTONIO AREA, TEXAS, 1934-80.
Edwards Underground Water District, San Antonio, TX.
Bulletin 40, October 1982. 128p, 4 fig, 9 tab, 89 ref.

Descriptors: *Water resources data, *Groundwater recharge, *Texas, *San Antonio, *Groundwater level, *Groundwater quality, *Edwards Aquifer, Data collections, Recharge, Water Quality.

The average annual groundwater recharge to the Edwards aquifer in the San Antonio area, Texas, from 1934 through 1980, was 594,000 acre-ft. The recharge during 1980 was 406,400 acre-ft. A maximum annual recharge of 1,711,200 acre-ft occurred during 1958, and a minimal annual recharge of 43,700 acre-ft occurred during 1956. The estimated annual discharge by wells and springs during 1980 was 819,400-acre-ft. A maximum annual discharge of 960,900 acre-ft occurred during 1977, and a minimum annual discharge of 388,800 acre-ft occurred during 1955. The annual discharge by wells was 491,100 acre-ft during 1980, which is a record high for 1934-80. Although water levels in many of the wells in the Edwards aquifer fluctuated near the midpoint between record high and low levels during the last 6 months of 1980, the volume of groundwater in storage in the aquifer was above average. Analyses of water samples from 61 wells and 3 springs show that the water is of a significantly better quality than the level established for public water systems. (Author's abstract)
W89-04649

RECORDS OF GROUND-WATER RECHARGE, DISCHARGE, WATER LEVELS, AND CHEMICAL QUALITY OF WATER FOR THE EDWARDS AQUIFER IN THE SAN ANTONIO AREA, TEXAS, 1934-81.
Edwards Underground Water District, San Antonio, TX.
Bulletin 41, February 1984. 135p, 4 fig, 9 tab, 64 ref.

Descriptors: *Water resources data, *Texas, *Groundwater recharge, *Groundwater level, *Groundwater quality, *Edwards Aquifer, *Data collections, San Antonio, Recharge, Water Quality.

The average annual groundwater recharge to the Edwards aquifer in the San Antonio area, Texas, from 1934 through 1981, was 612,400 acre-ft. The recharge in 1981 was 1,448,400 acre-ft, which is the third highest annual recharge since 1934. A maximum annual recharge of 1,711,200 acre-ft occurred in 1958, and a minimum annual recharge of 43,700 acre-ft occurred in 1956. The calculated annual discharge by wells and springs in 1981 was 794,400 acre-ft. Annual discharge by wells and springs ranged from a maximum of 960,900 acre-ft in 1977 to a minimum of 388,800 acre-ft in 1955. The annual discharge by wells was 387,100 acre-ft in 1981. Although water levels in many of the wells in the Edwards aquifer fluctuated near the midpoint between record high and low levels during the first 5 months of 1981, the volume of groundwater in storage in the aquifer was above average for most of the year. Analyses of water samples from 56 wells and 3 springs show that the water is of a significantly better quality than the level established for public water systems. (Author's abstract)
W89-04650

RECORDS OF GROUND-WATER RECHARGE, DISCHARGE, WATER LEVELS, AND CHEMICAL QUALITY OF WATER FOR THE EDWARDS AQUIFER IN THE SAN ANTONIO AREA, TEXAS, 1934-82.
Edwards Underground Water District, San Antonio, TX.
Bulletin 42, March 1985. 131p, 6 fig, 10 tab, 57 ref.

Descriptors: *Water resources data, *Groundwater recharge, *Groundwater level, *Groundwater quality, *Edwards Aquifer, *Data collections, *Texas, San Antonio, Recharge, Water Quality, Organic compounds.

The average annual groundwater recharge to the Edwards aquifer in the San Antonio area, Texas, from 1934 through 1982, was 608,400 acre-ft. The recharge in 1982 was 417,700 acre-ft. A maximum annual recharge of 1,711,200 acre-ft occurred in 1958, and a minimum annual recharge of 43,700 acre-ft occurred in 1956. The calculated annual discharge by wells and springs in 1982 was 786,400 acre-ft. Annual discharge by wells and springs ranged from a maximum of 960,900 acre-ft in 1977 to a minimum of 388,800 acre-ft in 1955. The annual discharge by wells was 453,100 acre-ft in 1982, which is the second highest discharge for the 1934-82 period of record. Although water levels in many of the wells in the Edwards aquifer fluctuated near the midpoint between record high and low levels during the summer of 1982, the volume of groundwater in storage in the aquifer was above average for most of the year. Analyses of water samples from 56 wells and 3 springs show that the water is of a significantly better quality than the level established for public water systems. However, trace concentrations of organic compounds were detected in some of the analyses. (Author's abstract)
W89-04651

COMPILATION OF HYDROLOGIC DATA FOR THE EDWARDS AQUIFER, SAN ANTONIO AREA, TEXAS, 1983-84, WITH 1934-84 SUMMARY.
Edwards Underground Water District, San Antonio, TX.
Bulletin 43-44, April 1986. 235p, 7 fig, 15 tab, 60 ref.

Descriptors: *Water resources data, *Groundwater recharge, *Groundwater level, *Groundwater quality, *Edwards Aquifer, *Data collections, *Texas, San Antonio, Recharge, Water Quality, Organic compounds.

The average annual groundwater recharge to the Edwards aquifer in the San Antonio area, Texas, for 1934-83 and 1934-84, was 604,700 and 596,700 acre-ft, respectively. Annual recharge for 1983 and 1984 was significantly below the average annual recharge. The recharge in 1983 was 420,100 acre-ft. Recharge in 1984 was 197,900 acre-ft, which is the ninth lowest estimated annual recharge since 1934. A maximum annual recharge of 1,711,200 acre-ft occurred in 1958, and a minimum annual recharge of 43,700 acre-ft occurred in 1956. The calculated annual discharge by wells and springs in 1983 and 1984 was 720,100 and 702,300 acre-ft, respectively. Annual discharge by wells and springs ranged from a maximum of 960,900 acre-ft in 1977 to a minimum of 388,800 acre-ft in 1955. The annual discharge by wells was 418,600 acre-ft in 1983. In 1984, the annual discharge by wells was 529,800 acre-ft, which is a record high for the 1934-84 period of record. Although water levels in many of the wells fluctuated near or below the midpoint between record high and low levels in 1983, the volume of groundwater in storage in the aquifer was above average during most of the year. In 1984, substantial declines occurred during the spring and summer, and water levels then fluctuated below average conditions in most of the wells. Water levels in many of the wells fluctuated just above the 1956 record low during the summer. The volume in storage in the aquifer was below average during most of 1984. Analyses of water samples from 158 wells and 3 springs in the Edwards aquifer show that the water in the freshwater zone is of a significantly better quality than the level established for public water systems. However, 62% of samples from 77 wells and 3 springs contained 1 or more organic compounds. Analyses of water samples collected from six wells in Bexar and Uvaalde Counties showed concentrations of tetrachloroethylene in excess of 5 micrograms/L. In 1984, samples were collected from wells along the 'bad-water' line to detect changes in water quality as the potentiometric head in the Edwards aquifer changed. (Author's abstract)
W89-04652

COMPILATION OF HYDROLOGIC DATA FOR THE EDWARDS AQUIFER, SAN ANTONIO AREA, TEXAS, 1985, WITH 1934-85 SUMMARY.
Edwards Underground Water District, San Antonio, TX.
Bulletin 45, July 1987. 163p, 6 fig, 5 tab, 64 ref, 4 append.

Descriptors: *Water resources data, *Groundwater recharge, *Groundwater level, *Groundwater quality, *Edwards Aquifer, *Data collections, Texas, San Antonio, Recharge, Water Quality, Organic compounds.

The average annual groundwater recharge to the Edwards aquifer in the San Antonio area, Texas, from 1934 through 1985 was 604,500 acre-ft. Recharge in 1985 was 1,003,300 acre-ft, which is the seventh highest estimated annual recharge since 1934. A maximum annual recharge of 1,711,200 acre-ft occurred in 1958, and a minimum annual recharge of 43,700 acre-ft occurred in 1956. The calculated annual discharge by wells and springs in 1985 was 856,500 acre-ft. Annual discharge by wells and springs ranged from a maximum of 960,900 acre-ft in 1977 to a minimum of 388,800 acre-ft in 1955. In 1985, the annual discharge by wells was 522,500 acre-ft. This is near the record high of 529,800 acre-ft in 1984. Although water levels in many of the wells fluctuated near or above the midpoint between record high and low levels in 1985, the volume of groundwater in storage in the aquifer was near average during most of the year. In 1985, substantial increases occurred during the fall and winter, and water levels then remained above average in most of the area. Analyses of water samples from 94 wells and 3 springs in the Edwards aquifer show that the water quality in the freshwater zone is significantly better than the level established for public water systems. However, trace concentrations of organic compounds were detected in many of the analyses. Analyses of water samples collected from nine wells in Uvalde County showed concentrations of tetrachloroethylene in excess of 5 micrograms/L. In 1985, samples were collected from wells along the 'bad-water' line to detect changes in water quality as the potentiometric head in the Edwards aquifer changed. (Author's abstract)
W89-04653

SIMULATION OF GROUND-WATER MOVEMENT IN THE '1,500- AND 1,700-FOOT' AQUIFER OF THE BATON ROUGE AREA, LOUISIANA,
Geological Survey, Baton Rouge, LA. Water Resources Div.
T. L. Huntzinger, C. D. Whiteman, and D. D. Knochenmus.
Louisiana Department of Transportation and Development, Baton Rouge, Water Resources Technical Report No. 34, 1985. 52p, 37 fig, 6 tab, 10 plates, 33 ref.

Descriptors: *Groundwater level, *Model studies, *Saline water intrusion, *Louisiana, *Groundwater movement, *Aquifers, *Simulation analysis, Baton Rouge, Groundwater depletion, Groundwater mining, Leakage, Pumping, Groundwater storage, Groundwater recharge, Drawdown.

Before 1920, very little water was withdrawn from the '1,500- and 1,700-ft' aquifer of the Baton Rouge area. Since then, the '1,500- and 1,700-ft' aquifer has become a major source of water (17 million gallons per day in 1979) for public supply in East Baton Rouge Parish. This groundwater development has caused a decline of 175 ft or more in the potentiometric surface in the area near the major pumping center. For simulation purposes, the units of the Baton Rouge aquifer system considered in this study consist of three layers: the '1,500-ft' and '1,700-ft' aquifers, treated together as a single layer -- the '1,500- and 1,700-ft' aquifer; the overlying '1,200-ft' aquifer; and the underlying '2,700-ft' aquifer with the intervening confining beds. The first test simulation, with pumping continued at the 1978-79 average rate for 39 years, indicated a maximum increase in drawdown of about 25 ft. The second test simulation, with a 30% increase in pumping from the 1978-79 rate (increased 5% every 6-yr period for 30 years), indicated an increased drawdown of about 50 ft. The third test simulation, with a stepped decrease of 30% in pumping over 30 years, indicated that drawdowns stabilized at the 1979 level near the cone of depression. The test simulations also indicated that water levels in wells in the aquifer south of the Baton Rouge fault are little affected by changes in pumping rates. The water budgets for the test simulations indicate that leakage contributes more than 40% of the water withdrawn, approximately 55% comes from storage, and less than 5% is supplied from constant-head sources in the recharge area. However, withdrawals from the '1,500- and 1,700-ft' aquifer are small relative to the total pumpage from the aquifers simulated; therefore, water budgets show very little change as to the source of water from one simulation to another. Potential water-quality problems exist both spatially and temporally. As a result of the development of the cone of depression, saltwater encroachment is occurring in the '1,500- and 1,700-ft' aquifer. (Author's abstract)
W89-04655

GROUND-WATER RESOURCES OF THE FILLMORE-HAUGHTON-RED CHUTE AREA, BOSSIER AND WEBSTER PARISHES, LOUISIANA,
Geological Survey, Baton Rouge, LA. Water Resources Div.
J. L. Snider.
Louisiana Department of Transportation and Development, Baton Rouge, Water Resources Technical Report No. 32, 1983. 21p, 2 fig, 3 tab, 3 plates, 5 ref.

Descriptors: *Water resources data, *Data collection, *Groundwater, *Well yield, *Groundwater quality, *Louisiana, Aquifers, Groundwater potential, Water resources, Iron, Hardness.

The Fillmore-Haughton-Red Chute area is suburban to Bossier City and Shreveport, LA. Population influx has resulted in increased water demands on the principal source (Wilcox-Carrizo aquifer) for water supply in the area. The Wilcox-Carrizo generally yields water satisfactory for drinking water supplies with little or no treatment. Where the beds are thin and fine-grained or silty, wells yield less than 40 gpm (gallons per minute). About half of the test holes drilled in the area do not penetrate sand beds capable of yielding at least 40 gpm. The Sparta aquifer in the northeastern part of the project area is a potential alternate source of water. At a well site 2-1/2 miles north of the project area, the Sparta aquifer contains water that is satisfactory for drinking water use without treatment. The theoretical specific capacity of a well screened in the Sparta aquifer at this site is 10 gpm/ft of drawdown. About a mile south of this site a test well penetrated a sand 67 ft in thickness in the Sparta, but the water has an iron concentration of 2.0 mg/L. The terrace aquifer is another alternate source of water in the area. This aquifer could sustain a continuous yield of about 100 gpm/sq mi. The water generally has an iron concentration $>$ 0.3 mg/L and a hardness $>$ 180 mg/L. This aquifer has been developed for public-supply and industrial use in parts of the area. In the Fillmore-Haughton-Red Chute area, the Red River alluvial aquifer contains water that has a hardness from 330 to 560 mg/L and an iron concentration from 0 .02 to 10 mg/L. Specific capacities as high as 25 gpm/ft of drawdown could be obtained in the project area. (Author's abstract)
W89-04656

WATER RESOURCES ACTIVITIES IN KENTUCKY, 1986.
Geological Survey, Louisville, KY. Water Resources Div.
For primary bibliographic entry see Field 7B.
W89-04658

GEOHYDROLOGY OF SANDSTONE AQUIFERS IN SOUTHWESTERN KANSAS,
Geological Survey, Lawrence, KS. Water Resources Div.
J. Kume, and J. M. Spinazola.
Kansas Geological Survey Irrigation Series 8, 1985. 49p, 24 fig, 9 tab, 45 ref.

Descriptors: *Groundwater potential, *Water resources data, *Aquifers, *Geohydrology, *Sandstone, Kansas, Water supply, Groundwater quality, Sodium bicarbonate, Calcium bicarbonate, Dissolved solids, Water use.

Sandstone aquifers in southwestern Kansas are a source of water for irrigation, industrial, municipal, domestic, and stock uses. An appraisal of water resources in sandstone aquifers underlying approximately 17,400 sq mi in 26 counties of southwestern Kansas shows that in some areas water is still available for additional well development. Additional water is needed to supplement decreasing supplies in the overlying Ogallala aquifer as demand for water increases. Major sandstone aquifers, in order of importance, occur in the Dakota Formation in the Lower Cretaceous Series, in undifferentiated rocks in the Upper Jurassic Series, and in the Cheyenne Sandstone in the Lower Cretaceous Series. Minor sandstone aquifers, in stratigraphic sequence, occur in undifferentiated rocks in the Upper Permian Series, in the Kiowa Formation in the Lower Cretaceous Series, and in the Coldell Sandstone Member of the Carlile Shale in the Upper Cretaceous Series. Aquifers in the Dakota Formation occur throughout most of the area, contain fresh to moderately saline water, range from 0 to approximately 150 ft in thickness, and yield up to 2,200 gal water/min to wells. Dissolved solids concentrations are $<$ 500 mg/L in water from the aquifers in the southern two-thirds of the area. Sodium bicarbonate and calcium bicarbonate are the most common chemical types of water. Dissolved solids concentrations in water from aquifers in Upper Jurassic rocks range from 296 to 517 mg/L. The aquifers in the Cheyenne Sandstone occur throughout most of the area, contain fresh to briny water, and range from 0 to 190 ft in thickness. Dissolved solids concentrations in water range from 192 to 51,000 mg/L. Sodium sulfate or sodium chloride water are the

common chemical types. Aquifers in rocks of Permian age occur throughout the area, reach a maximum depth of approximately 2,100 ft in Wallace County, and generally contain saline to briny water. Dissolved solids concentrations in water range from 89 to 51,000 mg/L. Sodium chloride and calcium sulfate are the common chemical types of water. Aquifers in the Kiowa Formation and in the Codell Sandstone Member of the Carlile Shale occur in the northeastern corner of the study area, are thin and discontinuous, and have a minor amount of stock- and domestic-well development. The aquifers in the Kiowa Formation range in thickness from 10 to 35 ft and the aquifers in the Codell Sandstone range in thickness from 0 to about 25 ft. (Author's abstract)
W89-04659

CLASSIFICATION AND DELINEATION OF RECHARGE AREAS TO THE BLACKSTONE AND LOWER BLACKSTONE-MOHASSUCK GROUND-WATER RESOURCES IN NORTH-EASTERN RHODE ISLAND,
Geological Survey, Providence, RI.
E. C. Todd Trench, and D. J. Morrissey.
Rhode Island Department of Environment Management Recharge Area Report 1, 1985. 21p, 4 fig, 1 plate, 14 ref.

Descriptors: *Water pollution sources, *Groundwater recharge, *Water quality, *Geohydrology, *Classification, *Groundwater reservoirs, Rhode Island, Aquifers, Stratification, Precipitation, Surface-groundwater relations, Manganese, Water pollution effects, Groundwater management.

Stratified-drift deposits, primarily in stream valleys, comprise Rhode Island's major aquifers. Where these deposits exceed transmissivity and saturated thickness values specified by the State, they are called groundwater reservoirs. Knowledge and proper management of areas that contribute recharge to groundwater reservoirs are necessary to prevent groundwater contamination. Recharge areas to unconfined aquifers can be classified and delineated by using topographic, geologic, and hydrologic information. Recharge areas to two groundwater reservoirs in a north-eastern Rhode Island stream-aquifer system are delineated on a 1:24,000-scale topographic map. The map also shows till/stratified drift contacts, water table contours, and municipal-supply wells. Three types of recharge areas are defined for each of the two groundwater reservoirs based on sources of recharge. Each groundwater reservoir is recharged by precipitation over the aquifer area, groundwater inflow from adjacent areas, and induced or natural infiltration or surface water derived from upstream drainage areas. Seven municipal wells in the aquifer areas of the Blackstone and Lower Blackstone-Mohassuck groundwater reservoirs are unused because of water quality problems such as high manganese concentration and industrial chemical contamination. Groundwater in both reservoirs is vulnerable to further contamination because of industrial and residential development and induced infiltration of poor quality surface water. Recharge area information can be used by managers in protecting groundwater quality. (Author's abstract)
W89-04663

WATER-RESOURCES DATA FOR THE LOWER JAMES RIVER, DICKEY, LAMOURE, AND STUTSMAN COUNTIES, NORTH DAKOTA,
Geological Survey, Bismarck, ND. Water Resources Div.
For primary bibliographic entry see Field 2E.
W89-04664

EFFECTS OF SAND REMOVAL ON THE SHALLOW AQUIFER IN THE VICINITY OF THE CAMUY MANGROVE FOREST, PUERTO RICO,
Geological Survey, San Juan, PR. Water Resources Div.
For primary bibliographic entry see Field 4C.
W89-04672

INTERPRETATION OF HYDROCHEMICAL FACIES OF GROUND WATER IN GRAND CAYMAN,
Water Authority, George Town (Cayman Islands).
For primary bibliographic entry see Field 2K.
W89-04673

USE OF BOREHOLE NEUTRON LOGS TO ESTIMATE MOISTURE CONTENT IN THE UNSATURATED ZONE OF AN ALLUVIAL AQUIFER,
Geological Survey, San Juan, PR. Water Resources Div.
For primary bibliographic entry see Field 7B.
W89-04674

GROUND-WATER FLOW CHARACTERISTICS DESCRIBED IN QUANTITATIVE DYE TRACING IN KARST TERRANE IN NORTH-CENTRAL, KENTUCKY,
Geological Survey, Louisville, KY. Water Resources Div.
For primary bibliographic entry see Field 7B.
W89-04676

MONITORING OF GROUNDWATER RESOURCES OR AN OUNCE OF PREVENTION IS WORTH A MILLION GALLONS OF WATER RESOURCES,
Terra-Vac, Dorado, PR.
For primary bibliographic entry see Field 5G.
W89-04678

ESTIMATES OF FRESHWATER PRODUCTION FROM COASTAL AQUIFERS USING AREA OF DIVERSION OF WELL FIELDS AND AREAL DISTRIBUTION OF CHLORIDE CONCENTRATIONS,
Geological Survey, Tuscaloosa, AL. Water Resources Div.
M. Planert.
IN: Third Caribbean Islands Water Resources Congress. Proceedings of a Symposium held in St. Thomas, U.S. Virgin Islands, July 22-25, 1986. p 83-86, 4 ref.

Descriptors: *Coastal aquifers, *Chlorides, *Water resources development, *Groundwater budget, *Saline water intrusion, *Florida, *Groundwater management, Water supply, Aquifers, Groundwater quality, Wells.

By using the concept of the area of diversion with a map of chloride concentrations, an estimate of lateral intrusion of saltwater to well fields can be obtained. Three of the four schemes described here (simulated increase of 5 Mgal/d (million gallons per day) in Orange County plus pumping 30 Mgal/d from four pumping centers in Osceola County, FL; Simulated largest withdrawal at Osceola County; simulated withdrawal of 5 Mgal/d from one pumping center in southwest Brevard County, FL; and simulated three pumping centers in the same area of southwestern Brevard County, FL, at a rate of 20 Mgal/d) could produce water of suitable quality. The results show an additional 50 Mgal/d could be produced from the Floridan aquifer system in Orange and Osceola Counties in addition to the 15 Mgal/d presently pumped from the well field in Orange County. The maximum amount of water available from a hypothetical well field in Osceola County was not determined. The technique of using the area of diversion for a well field superimposed on the areal distribution of chloride concentrations can be used semi-quantitatively to ascertain the quality of water produced by the field. This technique evaluates lateral intrusion only but should be valid for most artesian situations where low vertical hydraulic conductivities restrict the vertical flow of water. This technique is not restricted to saltwater intrusion problems but should be viable to any evaluation of lateral movement of poor quality water due to pumpage. (See also W89-04665) (Lantz-PTT)
W89-04680

SIMULATION OF THE FLOW SYSTEM IN THE SHALLOW AQUIFER, DAUPHIN ISLAND, ALABAMA,
Geological Survey, Tuscaloosa, AL. Water Resources Div.
For primary bibliographic entry see Field 5B.
W89-04681

GROUND-WATER DATA FOR BOTTINEAU AND ROLETTE COUNTIES, NORTH DAKOTA,
Geological Survey, Bismarck, ND. Water Resources Div.
R. L. Kuzniar, and P. G. Randich.
North Dakota State Water Commission County Ground-Water Studies 35-Part II. North Dakota Geological Survey Bulletin 78-Part II, 1982. 742p, 2 fig, 2 plates, 5 tab, 55 ref.

Descriptors: *Water resources data, *Groundwater, *Data collections, *Hydrologic studies, *Hydrologic data collections, *North Dakota, Geohydrology, Groundwater level, Lithologic logs, Geophysics, Chemical analysis.

The investigation of the geology and occurrence of groundwater in Bottineau and Rolette Counties was made cooperatively by the U.S. Geological Survey, North Dakota State Water Commission, North Dakota Geological Survey, Bottineau County Water Management District, and Rolette County Water Management District. The results of the investigation are published in three separate parts. Part I is an interpretive report describing the geology of the study area, Part II is a compilation of the groundwater data, and Part III is an interpretive report describing the groundwater resources. Part II (this report) makes available geologic and hydrologic data collected during the county investigation and functions as a reference for the other reports. The data consist of the following: (1) geologic and hydrologic records of wells and test holes; (2) water level measurements in observation wells; (3) lithologic and geophysical logs of test holes and wells; and (4) chemical analyses of groundwater. The data provided are useful for evaluating geologic and groundwater conditions in Bottineau and Rolette Counties. However, use of the data as a guide to conditions at different sites should be made with caution because of the lenticular character of the water-bearing rocks and varying water quality in some aquifers. (Lantz-PTT)
W89-04683

GROUND-WATER DATA FOR TOWNER COUNTY, NORTH DAKOTA,
Geological Survey, Bismarck, ND. Water Resources Div.
R. L. Kuzniar, and P. G. Randich.
North Dakota State Water Commission County Ground-Water Studies 36-Part II. North Dakota Geological Survey Bulletin 79-Part II, 1983. 280p, 2 fig, 5 tab, 1 plate, 24 ref.

Descriptors: *Water research data, *Hydrologic data collections, *North Dakota, *Groundwater, *Data collections, *Hydrologic studies, Geohydrology, Groundwater level, Lithologic logs, Geophysics, Chemical analysis.

The investigation of the geology and occurrence of groundwater in Towner County was made cooperatively by the U.S. Geological Survey, North Dakota State Water Commission, North Dakota Geological Survey, and Towner County Board of Commissioners. The results of the investigation are published in three separate parts. Part I is an interpretive report describing the geology of the study area, Part II is a compilation of the groundwater data, and Part III is an interpretive report describing the groundwater resources. Part II (this report) makes available geologic and hydrologic data collected during the county investigation and functions as a reference for the other reports. The data consist of the following: (1) geologic and hydrologic records of wells and test holes; (2) water level measurements in observation wells; (3) lithologic and geophysical logs of test holes and wells; and (4) chemical analyses of groundwater. The data provided are useful for evaluating geologic and groundwater conditions in Towner County. However, use of the data as a guide to conditions at different sites should be made with

caution because of the lenticular character of the water-bearing rocks and varying water quality in some aquifers. (Lantz-PTT)
W89-04684

GROUND-WATER DATA FOR MCKENZIE COUNTY, NORTH DAKOTA,
Geological Survey, Bismarck, ND. Water Resources Div.
M. G. Croft.
North Dakota State Water Commission County Ground-Water Studies 37 Part II. North Dakota Geological Survey Bulletin 80-Part II, 1983. 455p, 2 fig, 7 tab, 1 plate, 24 ref.

Descriptors: *Water resources data, *Groundwater, *Data collections, *Hydrologic studies, *North Dakota, Geohydrology, Hydrologic data collections, Groundwater level, Lithologic logs, Geophysics, Chemical analysis.

The investigation of the geology and occurrence of groundwater in McKenzie County was made cooperatively by the U.S. Geological Survey, North Dakota State Water Commission, North Dakota Geological Survey, and McKenzie County Water Resource District. The results of the investigation are published in three separate parts. Part I is an interpretive report describing the geology of the study area, Part II is a compilation of the groundwater data, and Part III is an interpretive report describing the groundwater resources. Part II (this report) makes available geologic and hydrologic data collected during the county investigation and functions as a reference for the other reports. The data consist of the following: (1) geologic and hydrologic records of wells and test holes; (2) water level measurements in observation wells; (3) lithologic and geophysical logs of test holes and wells; and (4) chemical analyses of groundwater. The data provided are useful for evaluating geologic and groundwater conditions in McKenzie County. However, use of the data as a guide to conditions at different sites should be made with caution because of the lenticular character of the water-bearing rocks and varying water quality in some aquifers. (Lantz-PTT)
W89-04685

GROUND-WATER RESOURCES OF LOGAN COUNTY, NORTH DAKOTA,
Geological Survey, Bismarck, ND. Water Resources Div.
R. L. Klausing.
North Dakota State Water Commission County Ground-Water Studies 34 - Part III, North Dakota Geological Survey Bulletin 77 - Part III, 1983. 42p, 7 fig, 3 tab, 3 plates, 44 ref.

Descriptors: *Water resources data, *Data collections, *Groundwater budget, *Water resources, *Aquifers, North Dakota, Glacial aquifers, Groundwater quality, Dissolved solids, Wells, Fox Hills aquifer, Pierre aquifer, Dakota aquifer.

Groundwater in Logan County is obtained from glacial-drift aquifers of Quaternary age and the Fox Hills, Pierre, and Dakota aquifers of Cretaceous age. Glacial-drift aquifers that have the greatest potential for development are the Streeter and Napoleon aquifer systems located in the north central and northwestern parts of the county. Properly constructed wells in the more permeable parts of these aquifer systems will yield 200 to 1,300 gpm (gallons per minute). Water from the glacial-drift aquifers is hard to very hard. Dissolved solids concentrations in water samples from these aquifers ranged from 298 to 2,640 mg/L. The Fox Hills aquifer underlies the western two-thirds of the county. Yields from this aquifer will range from 0.5 to about 60 gpm. Dissolved solids concentrations in water samples from this aquifer ranged from 347 to 2,490 mg/L. The Pierre aquifer underlies the eastern one-third of the county. Yields from this aquifer will range from 0.25 to 10 gpm. Water is obtained from fractures in the upper part of the aquifer and from hydraulically connected sand and gravel deposits at the base of the overlying glacial till. The water predominantly is a sodium chloride type. Dissolved solids concentrations in water samples from this aquifer ranged from 1,300 to 6,590 mg/L. The Dakota aquifer underlies the entire county at depths ranging from 2,100 to 2,400 ft. This aquifer will yield as much as 1,000 gpm to properly constructed wells. The water in the aquifer, based on one sample, is a calcium-sodium sulfate type. Dissolved solids concentration in the sample was 2,220 mg/L. (Author's abstract)
W89-04686

GROUND-WATER RESOURCES OF MCKENZIE COUNTY, NORTH DAKOTA,
Geological Survey, Bismarck, ND. Water Resources Div.
M. G. Croft.
North Dakota State Water Commission County Ground-Water Studies 37 - Part III. North Dakota Geological Survey Bulletin 80 - Part III, 1985. 57p, 26 fig, 9 tab, 2 plates, 59 ref.

Descriptors: *Water resources data, *Data collections, *Groundwater budget, *North Dakota, Irrigation water, Domestic water, Industrial water, Municipal water, Aquifers, Dissolved solids, Wells, Groundwater quality, Water use.

Groundwater suitable for domestic and livestock supplies in McKenzie County is available from three aquifer systems in semiconsolidated rocks of Late Cretaceous and Tertiary age. Groundwater from aquifers in unconsolidated sand and gravel of Quaternary age is suitable for domestic, livestock, municipal, industrial, and irrigation uses. Rocks older than Late Cretaceous age extend to 15,000 ft and generally contain brackish water that is unsuitable for most purposes. The Fox HIlls and basal Hell Creek aquifer system is used as a source for livestock and domestic supplies. It generally is 1,100 to 1,800 ft in depth, and the transmissivity is 200 to 300 sq ft/d. The water is lower in dissolved solids than water in overlying aquifers of Tertiary age and has a median dissolved solids concentration of about 1,325 mg/L. Wells may yield 100 gpm (gallons per minute). Six aquifers, each consisting of 50 to 176 ft of unconsolidated sand and gravel could yield 100 to more than 500 gpm. The water from four of the aquifers generally is a sodium bicarbonate type and has a median dissolved solids concentration of 1,100 to 2,330 mg/L. Water from the Charbonneau, Tobacco Garden, and Yellowstone-Missouri aquifers is suitable for irrigation. (Author's abstract)
W89-04687

STUDY OF INTERRELATED SOIL-WATER, GROUND-WATER AND RIVER FLOWS,
Akademiya Nauk SSSR, Moscow. Inst. Vodnykh Problem.
For primary bibliographic entry see Field 2E.
W89-04711

INFLUENCE OF EVAPOTRANSPIRATION ON THE GROUNDWATER TABLE IN PEATLAND,
Hokkaido Univ., Sapporo (Japan). Dept. of Agricultural Engineering.
Y. Umeda, M. Shimizu, and T. Inoue.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu, Finland, 6-8 June 1988. Vol. 1. The Academy of Finland, Helsinki, Finland. 1988. p 164-169, 5 fig, 1 tab, 3 ref.

Descriptors: *Wetlands, *Soil-water-plant relationships, *Evapotranspiration, *Water table fluctuations, *Groundwater level, *Peat bogs, Japan, Land use, Vegetation effects, Drainage effects, Hydrologic models, Model studies, Seasonal variation, Cultivation.

Groundwater level measurements were carried out for several peatlands in Hokkaido, northern Japan. Peatland tank models for groundwater table fluctuations were used to evaluate the patterns of groundwater table fluctuations at sites in Sarobetsu Genseikaen-W, Bibai Nakanosawa-W, and Kushiro Akanuma. Groundwater table fluctuations were classified into five categories according to their fluctuating patterns, hydrological conditions, and land use of investigated peatlands. Results of measurements of groundwater table fluctuations in these peatlands suggest a strong influence of evapotranspiration. The groundwater table fluctuations at Kushiro Akanuma showed a distinct stepwise fall during dry periods, with a steep fall occurring in the daytime and a gentle fall or no change of water table occurring at night. This form of water table fluctuation is obviously caused by evapotranspiration. Similar but more gentle patterns of groundwater table fluctuations can be seen in Sarobetsu. At Bibai, the surface surrounding the observation site was tilled and almost all plants were cut down (except about a 25 sq m plot for observation with vegetation) on June 28th. Since that day, the observed water table indicated high levels against the calculated value due to the reduction of transpiration effect caused by tillage. An influence of seasonal changes on plant condition was also identified in relation to the groundwater table fluctuation. At Kushiro Akanuma, herbaceous layer plants begin to wither in September making the effect of evapotranspiration appear obvious in October. (See also W89-04689) (Geiger-PTT)
W89-04712

DITCH CLEANING AND ADDITIONAL DITCHING IN PEATLAND FORESTRY: EFFECT ON GROUND WATER LEVEL,
Helsinki Univ. (Finland). Dept. of Peatland Forestry.
For primary bibliographic entry see Field 4A.
W89-04715

PRELIMINARY EFFECTS OF FOREST DRAINAGE IN ALBERTA, CANADA ON GROUNDWATER TABLE LEVELS AND STREAM WATER QUALITY,
Northern Forest Research Centre, Edmonton (Alberta).
For primary bibliographic entry see Field 4C.
W89-04716

SOIL MOISTURE - GROUNDWATER RELATION IN THE FLOODPLAIN AREA OF THE DANUBE RIVER,
Vyskumny Ustav Vodohospodarsky, Bratislava (Czechoslovakia).
For primary bibliographic entry see Field 2G.
W89-04737

LAS VEGAS SW QUADRANGLE GROUND WATER MAP,
Geological Survey, Carson City, NV. Water Resources Div.
T. Katzer, J. R. Harrill, G. Berggren, and R. W. Plume.
Nevada Bureau of Mines and Geology, Las Vegas Area, Map 3Bf, 1985. 1 p (map).

Descriptors: *Nevada, *Groundwater budget, *Maps, Artesian wells, Groundwater quality, Groundwater runoff, Groundwater recharge.

This map is a contour representation of groundwater depth in the Las Vegas SW Quadrangle, March 1979. Control point wells, flowing artesian wells, groundwater quality, groundwater discharge, and area of potential groundwater recharge are illustrated. (Lantz-PTT)
W89-04829

GROUNDWATER SYSTEMS PLANNING AND MANAGEMENT,
Humboldt State Univ., Arcata, CA. Dept. of Environmental Resources Engineering.
For primary bibliographic entry see Field 4B.
W89-04830

EDWARDS AQUIFER. EXTREMELY PRODUCTIVE, BUT.... A SOLE-SOURCE WATER SUPPLY FOR SAN ANTONIO AND SURROUNDING COUNTIES IN SOUTH-CENTRAL TEXAS,
Geological Survey, San Antonio, TX.
C. R. Burchett, P. L. Rettman, and C. W. Boning.
Edwards Underground Water Distrib, San Antonio, TX, 1986. 38p, 24 ref.

Descriptors: *Edwards Aquifer, *Groundwater management, *Water resources development, Research priorities, Groundwater budget, Groundwater quality.

The Edwards Underground Water District is a local unit of government created by the Texas Legislature in 1959 for the purpose of conserving, protecting, and recharging the groundwater. The District is empowered in various ways to accomplish its purpose. Among these are to cause investigations to be made of the groundwater resources; to develop comprehensive plans for the most efficient use and prevention of waste and pollution; to collect, preserve, and publish information and bring it to the attention of the users of the water within the District. Investigations and research concerning the Edward Aquifer are summarized and presents the information presented in a manner intended to be beneficial to everyone that makes decisions about the use of water. (Lantz-PTT)
W89-04831

BEDROCK TOPOGRAPHY AND GLACIAL DEPOSITS OF THE COLONIE CHANNEL BETWEEN SARATOGA LAKE AND COEYMANS, NEW YORK WITH A SECTION ON THE GROUND-WATER POTENTIAL OF THE CAPITAL DISTRICT BURIED-VALLEY DEPOSITS,
Geological Survey, Albany, NY. Water Resources Div.
R. J. Dineen, E. L. Hanson, and R. M. Waller.
New York State Museum Map and Chart Series Number 37, 1983. 55p, 5 plates, append.

Descriptors: *Water resources data, *New York, *Geohydrology, *Maps, *Topography, *Topographic mapping, *Glacial drift, *Saratoga Lake, *Groundwater budget, Bedrock, Aquifers, Glacial aquifers.

Two separate reports on glacial-aquifers, -sediments, and -lakes in New York State are given in this document, along with 5 plates which contain geologic maps and information on these deposits. (See also W89-04836 and W89-04837) (Lantz-PTT)
W89-04835

BEDROCK TOPOGRAPHY AND GLACIAL DEPOSITS OF THE COLONIE CHANNEL BETWEEN SARATOGA LAKE AND COEYMANS, NEW YORK,
New York State Geological Survey/State Museum, Albany.
R. J. Dineen, and E. L. Hanson.
IN: Bedrock Topography and Glacial Deposits of the Colonie Channel Between Saratoga Lake and Coeymans, New York with a section on the Ground-Water Potential of the Capital District Buried-Valley Deposits. New York State Museum Map and Chart Series Number 37, 1985. p 1-24, 8 fig, 6 tab, 30 ref.

Descriptors: *Water resources data, *Geohydrology, *Maps, *Bedrock, *Topography, *Glacial drift, *Colonie Channel, *New York, *Aquifers, Saratoga Lake, Clay, Groundwater recharge, Geohydrology, Lakes, Silt.

The Colonie Channel is a buried, glacially scoured valley with a U-shaped cross section that lies within the Hudson-Champlain Lowlands of east-central New York. The buried valley deepens from 50 to 120 m and widens from 1.6 to 3.2 km from north to south. The valley has a V-shaped inner gorge. The location of the valley is controlled by folded shale and graywacke. The sediments that bury the Colonie Channel are Wisconsinan in age. They were deposited in Glacial Lakes Albany, Quaker Springs, Coveville and Fort Ann as the Woodfordian glacier retreated. Seven units occupy the valley. Till is the oldest Pleistocene deposit in the valley; its thickness ranges from 1 to 30 m, and it is dense, compact, impermeable, bouldery to gravelly clay. Till acts as an aquiclude. Above the till lies outwash and ice-contact sand and gravel, a unit that ranges in thickness from 3 to 15 m, and is permeable stratified sand, silt, and gravel. This sand and gravel aquifer is recharged by discontinuous exposures along the valley sides. The sand and gravel is overlain by lake silt and clay that form a 1 to 60 m thick aquiclude. The silt and clay are impermeable, varved, and grade upward into lake sand and silty sand. The lake sand and silty sand are 15 to 30 m of stratified sand and silt, and form a near-surface aquifer. Delta sand and gravel grade laterally and downward into silty sand. The deltaic unit is 1 to 50 m thick and is permeable and stratified, forming a good aquifer. The lake units are overlain by Woodfordian to Holocene aeolian sand that ranges in thickness from 1 to 30 m and is stratified very fine to fine sand. Holocene floodplain deposits occur along rivers and streams, are 1 to 12 m thick, and are gravelly to silty sand with organic matter. Floodplain deposits are a very good potential aquifer. (See also W89-04835) (Author's abstract)
W89-04836

GROUND-WATER POTENTIAL OF THE CAPITAL DISTRICT BURIED-VALLEY DEPOSITS,
Geological Survey, Albany, NY. Water Resources Div.
R. M. Waller.
IN: Bedrock Topography and Glacial Deposits of the Colonie Channel Between Saratoga Lake and Coeymans, New York with a section on the Ground-Water Potential of the Capital District Buried-Valley Deposits. New York State Museum Map and Chart Series Number 37, 1985. p 25-55, 1 fig, 5 ref.

Descriptors: *Water resources data, *Geohydrology, *Potential water supply, *Groundwater budget, *Capital District, *New York, *Aquifers, Aquifer systems, Permeability coefficient, Seismology.

Twenty-two test holes were drilled into the preglacial buried-valley system in the Capital District area and penetrated deep confined aquifers. Yields of several thousand gallons per minute are estimated to be feasible from properly constructed wells tapping these aquifers. The test holes were drilled open hole and logged by natural-gamma, resistivity, and self-potential probes. Gamma logging proved adequate to distinguish sand and gravel units beneath the thick glaciolacustrine clay and silt; electric logs aided in determining water-bearing potential of the units. Data from most sites extended knowledge of the deep-aquifer system, and many sites were found to contain coarse, permeable zones that show promise of high water yields. Most sand and gravel units probably are continuous with adjacent surficial glacial ice-contact, outwash, or deltaic deposits. Hydraulic conductivity along the preglacial valley is not consistent, but sand and gravel is present within most of the inner gorge. Seismic profiles can aid in refining knowledge of the areal extent and cross-sectional details of the relatively narrow gorge within much of the valley system. (See also W89-04835) (Author's abstract)
W89-04837

EPA ACTIVITIES RELATED TO SOURCES OF GROUND-WATER CONTAMINATION.
Environmental Protection Agency, Washington, DC. Office of Ground-Water Protection.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-111901. Price codes: A06 in paper copy, A01 in microfiche. February 1987. 125p, 10 exhibits, 5 ref.

Descriptors: *Groundwater protection, *Water quality control, *Regulations, *Water pollution sources, Surveys, Groundwater quality, Federal jurisdiction.

The Office of Ground-Water Protection (OGWP) undertook a special project during the summer and fall of 1986 in which all Headquarters program offices and Regional offices were surveyed to determine the type, scope, and status of groundwater quality protection activities that were being conducted by the Agency. The survey focused on Agency activities that address 33 sources of groundwater contamination listed in the 1984 Office of Technology Assessment (OTA) report 'Protecting The Nation's Groundwater from Contamination.' This list contains sources ranging from landfills to road salt applications. Approximately 270 EPA programs and activities that address these 33 OTA-listed sources are listed. Inventory information was obtained through a work group composed of liaisons appointed by each Assistant Administrator and representatives of each Regional Ground-Water Office. This group in turn developed a large network of EPA staff who supplied and reviewed the program and activity listings and summaries contained in the report. (Lantz-PTT)
W89-04851

GUIDELINES FOR DELINEATION OF WELLHEAD PROTECTION AREAS.
Environmental Protection Agency, Washington, DC.
For primary bibliographic entry see Field 5G.
W89-04852

WATERSHEDS,
For primary bibliographic entry see Field 5B.
W89-04864

AQUIFER TEST EVALUATION AND POTENTIAL EFFECTS OF INCREASED GROUNDWATER PUMPAGE AT THE STOVEPIPE WELLS HOTEL AREA, DEATH VALLEY NATIONAL MONUMENT, CALIFORNIA,
Geological Survey, Sacramento, CA. Water Resources Div.
L. R. Woolfenden, P. Martin, and B. Baharie.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 87-4270, 1988. 26p, 12 fig, 3 tab, 7 ref.

Descriptors: *Water resources data, *Groundwater, *Aquifer testing, *Pumpage, *California, Water treatment, Reverse osmosis, Tourism, Groundwater level, Phreatophytes, Transmissivity, Storage coefficient, Theis equation, Drawdown, Observation wells.

Ground-water use in the Stovepipe Wells Hotel area in Death Valley National Monument is expected to increase significantly if the nonpotable, as well as potable, water supply is treated by reverse osmosis. During the peak tourist season, October through March, ground-water pumpage could increase by 37,500 gallons per day, or 76%. The effects of this additional pumpage on water levels in the area, particularly near a strand of phreatophytes about 10,000 feet east of the well field, are of concern. In order to evaluate the effects of increased pumpage on water levels in the Stovepipe Wells Hotel area well field, two aquifer tests were performed at the well field to determine the transmissivity and storage coefficients of the aquifer. Analysis of the aquifer test determined that a transmissivity of 1,360 feet squared per day was representative of the aquifer. The estimated value of transmissivity and the storage-coefficient values that are representative of confined (1.2 x .0004) and unconfined (0.25) conditions were used in the Theis equation to calculate the additional drawdown that might occur after 1, 10, and 50 years of increased pumpage. The drawdown calculated by using the lower storage-coefficient value represents the maximum additional drawdown that might be expected from the assumed increase in pumpage; the drawdown calculated by using the higher storage-coefficient value represents the minimum additional drawdown. Calculated additional drawdowns after 50 years of pumping range from 7.8 feet near the pumped well to 2.4 feet at the phreatophyte stand assuming confined conditions, and from 5.7 feet near the pumped well to 0.3 foot at the phreatophyte stand assuming unconfined conditions. Actual drawdowns probably will be somewhere between these values. Drawdowns measured in observation wells during 1973-85, in response to an average pumpage of 34,200 gallons per day at the Stovepipe Wells Hotel well field, are similar to the drawdowns calculated by the Theis equation for the assumed increase in pumpage. (Author's abstract)
W89-04903

SELECTED REPORTS THAT INCLUDE COMPUTER PROGRAMS PRODUCED BY THE U.S. GEOLOGICAL SURVEY FOR SIMULATION OF GROUND-WATER FLOW AND QUALITY,
Geological Survey, Reston, VA. Water Resources Div.
C. A. Appel, and T. E. Reilly.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 87-4271, 1988. 64p, 71 ref.

Descriptors: *Groundwater movement, *Water quality, *Simulation, *Computer programs, *Model studies, *Literature review, Computer models, Statistical models.

A summary list of reports that document numerical models that simulate ground-water flow and quality is presented. The list documents the reference by giving a description of each model program, its numerical features, a qualitative expression of the number of past applications and where to obtain a copy. All reports included in the list have been published or developed by the U.S. Geological Survey and most contain listings of the computer programs. (Author's abstract)
W89-04904

GROUND-WATER FLOW BENEATH LEVEE 35A FROM CONSERVATION AREA 2B, BROWARD COUNTY, FLORIDA,
Geological Survey, Tallahassee, FL. Water Resources Div.
L. J. Swayze.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 87-4280, 1988. 22p, 8 fig, 2 tab, 11 ref.

Descriptors: *Seepage, *Articial recharge, *Groundwater movement, *Levees, *Florida, Recharge, Aquifers, Pressure head, Canals, Underflow.

Conservation Area 2B is an area of recharge for the surficial aquifer system in Broward County. Water stored in the conservation area provides the hydraulic potential for downward flow to the high permeability zone of the Biscayne aquifer. A 5.64 ft head differential (average for the period of record) between water levels in Conservation Area 2B and water levels in the adjacent levee 35A borrow canal causes water to leak into the canal at an average rate of about 0.0022 cu ft per sec per lineal foot of canal and accounts for a loss of 0.013 foot per day of surface water from Conservation Area 2B. Amounts of canal leakage and underflow are constantly changing and are dependent upon the head differential between Conservation Area 2B and the levee 35A borrow canal. (Author's abstract)
W89-04906

PERCENTAGE CHANGE IN SATURATED THICKNESS OF THE HIGH PLAINS AQUIFER, WEST-CENTRAL KANSAS, 1950 TO AVERAGE 1985-87,
Geological Survey, Lawrence, KS. Water Resources Div.
B. J. Dague.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 87-4252, 1987. 1p (map), 14 ref.

Descriptors: *Groundwater mining, *High Plains Aquifer, *Groundwater level, *Maps, *Aquifer characterics, *Saturation zone, *Kansas, Groundwater management, Hydrologic maps, Groundwater level, Observation wells, Bedrock, Irrigation effects, Withdrawal, Pumpage.

Continuing studies are being made in west-central Kansas to provide up-to-date information that will aid in the management of groundwater for irrigation. This report presents the results of the seventh in a series of studies that uses a statistical technique, called kriging, to produce hydrologic maps. The kriging technique interpolates water-level altitudes at the center of each 1-square-mile section in the study area on the basis of water-level measurements from 164 observation wells. These interpolated altitudes (1859 in all), along with bedrock-surface and base-year water-level altitudes were used to prepare a hydrologic map that illustrates percentage change in saturated thickness. Saturated thickness, as used in this report, is the thickness of the High Plains Aquifer between the groundwater surface, as indicated by water-level altitudes, and the bedrock surface. Because irrigation development in west-central Kansas was minimal prior to 1950, the saturated thickness during 1950 represented a nearly static condition in the aquifer. Thus, the decrease in saturated thickness of the aquifer since 1950 is related to the effects of irrigation withdrawals on the volume of water in storage. In general, percentage change in saturated thickness indicates the degree of stress on the aquifer in most areas resulting from irrigation pumpage. (Shidler-PTT)
W89-04908

EFFECT OF NIAGARA POWER PROJECT ON GROUND WATER FLOW IN THE UPPER PART OF THE LOCKPORT DOLOMITE, NIAGARA FALLS AREA, NEW YORK,
Geological Survey, Ithaca, NY. Water Resources Div.
T. S. Miller, and W. M. Kappel.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4130, 1987. 31p, 16 fig, 1 plate (map), 2 tab, 13 ref.

Descriptors: *Dam effects, *Groundwater movement, *Groundwater level, *Groundwater flow, *Powerplants, *New York, *Niagara Falls, Recharge, Potentiometric level, Pressure head, Dolomite, Canals, Pumped storage, Storage reservoirs, Drains, Tunnels, Seepage, Water level fluctuations.

The Niagara River Power Project near Niagara Falls, N.Y., has created recharge and discharge areas that have modified the direction of groundwater flow east and northeast of the falls. Before construction of the power project in 1962, the configuration of the potentiometric surface in the upper part of the Silurian Lockport Dolomite generally paralleled the buried upper surface of the bedrock. Ground water in the central and east parts of the city of Niagara Falls flowed south and southwestward toward the upper Niagara River (above the falls), and ground water in the western part flowed westward into Niagara River gorge. The power project consists of two hydroelectric powerplants separated by a forebay canal that receives water from the upper Niagara River through two 4-mi-long, parallel, buried conduits. During periods of nonpeak power demand, some water in the forebay canal is pumped to a storage reservoir for later release to generate electricity during peak-demand periods. Since the power project began operation in 1962, groundwater within 0.5 mi of the buried conduits has seeped into the drain system that surrounds the conduits, then flows both south from the forebay canal and north from the Niagara River toward the Falls Street tunnel--a former sewer that crosses the conduits 0.65 mi north of the upper Niagara River. Approximately 6 million gallons of ground water a day leaks into the Falls Street tunnel, which carries it 2.3 mi westward to the Niagara River gorge below the falls. Daily water-level fluctuations in the forebay canal affect water levels in the drain system that surrounds the conduits, and this, in turn, affects the potentiometric surface in the Lockport Dolomite within 0.5 mi of the conduits. The drains transmit changes in pressure head near the forebay canal southward at least as far as the Falls Street tunnel area and possibly to the upper Niagara River. Some water in the pumped-storage reservoir recharges ground water in the Lockport Dolomite by seepage through bedding joints, which are exposed in the unlined reservoir bottom, and through the grout curtain beneath the reservoir's dike. Water-level fluctuations in the reservoir cause slight ground-water fluctuations near the reservoir. (Author's abstract)
W89-04913

STATISTICAL ANALYSIS RELATING WELL YIELD TO CONSTRUCTION PRACTICES AND SITING OF WELLS IN THE PIEDMONT AND BLUE RIDGE PROVINCES OF NORTH CAROLINA,
Geological Survey, Raleigh, NC. Water Resources Div.
C. C. Daniel.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4132, 1987. 54p, 14 fig, 7 tab, 48 ref.

Descriptors: *Well yield, *Well construction methods, *Groundwater movement, *Siting, *Statistical analysis, *North Carolina, Well data, Crystalline rocks, Geologic fractures, Geohydrologic units, Geology, Topography, Industrial development, Human population, Surface water, Water supply development, Groundwater mining.

A statistical analysis was made of data from more than 6,200 water wells drilled in the fractured crystalline rocks of the Blue Ridge, Piedmont, and western edge of the Coastal Plain where crystalline rocks underlie sediments at shallow depths. The study area encompassed 65 countries in western North Carolina, an area of 30,544 square mi, comprising nearly two-thirds of the State. Additional water supplies will be needed in western North Carolina as population and industrial development continue to increase. Ground water is an attractive alternative to surface water sources for moderate to large supplies. The statistical analysis was made to identify the geologic, topographic, and construction factors associated with high-yield wells. It is generally held that the crystalline rocks of Blue Ridge and Piedmont provinces yield only small amounts of water to wells, that water is obtained from vertical fractures that pinch out at a depth of about 300 feet because of lithostatic pressure, and that the function of a larger diameter well is primarily for storage. These concepts are reasonable when based upon the average well drilled in these rocks: a domestic well, 125 feet deep, 6 inches or less in diameter, and located on a hill or ridge. However, statistical analysis shows that wells in draws or valleys have average yields three times those of wells on hills and ridges. Wells in the most productive hydrogeologic units have average yields twice those of wells in the least productive units. Wells in draws and valleys in the most productive units average five times more yield than wells on hills and ridges in the least productive units. Well diameter can have significant influence on yield; for a given depth, yield is directly proportional to well diameter. Maximum well yields are obtained from much greater depths than previously believed. For example, the average yield of 6-inch diameter wells located in draws and valleys can be expected to reach a maximum of about 45 gallons per minute at depths of 500 to 525 feet; for similarly located 12-inch diameter wells, the average yield can be expected to reach a maximum of about 150 gallons per min at depths of 700 to 800 ft. (Author's abstract)
W89-04914

FLOW TESTING OF THE NEWBERRY 2 RESEARCH DRILLHOLE, NEWBERRY VOLCANO, OREGON,
Geological Survey, Menlo Park, CA. Water Resources Div.
S. E. Ingebritsen, W. W. Carothers, R. H. Mariner, J. S. Gudmundsson, and E. A. Sammel.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4133, 1986. 23p, 6 fig, 2 tab, 11 ref.

Descriptors: *Test wells, *Aquifer testing, *Drill holes, *Volcanoes, *Geothermal studies, *Oregon, Flow rates, Steam, Carbon dioxide, Enthalpy, Temperature gradient, Conduction, Convection, Flow.

A 20 hour flow test of the Newberry 2 research drillhole at Newberry Volcano produced about 33,000 kilograms of fluid. The flow rate declined from about 0.8 kilograms per sec to less than 0.3 kilograms per sec during the course of the test. The mass ratio of liquid water to vapor was about 3:2 at the separator and stayed fairly constant

throughout the test. The vapor phase was about half steam and half CO2 by weight. The average enthalpy of the steam/water mixture at the separator was about 1,200 kilojoules per kilogram. Because of the low flow rate and the large temperature gradient into the surrounding rocks, heat loss from the wellbore was high; a simple conductive model gives overall losses of about 1,200 kilojoules per kilogram of H2O produced. The actual heat loss may have been even higher due to convective effects, and it is likely that the fluid entering the bottom of the wellbore was largely or entirely steam and CO2. (Author's abstract)
W89-04915

GEOLOGY OF THE SURFICIAL AQUIFER SYSTEM, DADE COUNTY, FLORIDA,
Geological Survey, Tallahassee, FL. Water Resources Div.
C. R. Causaras.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, Co 80225. USGS Water Resources Investigations Report 86-4126. 1987. 249p, 3 sheets (maps), 1 fig, 18 ref.

Descriptors: *Geohydrology, *Water resources data, *Groundwater resources, *Aquifers, *Florida, *Maps, *Lithologic logs, Tamiami Formation, Hawthorn Formation, Geology.

The geologic framework of the surficial aquifer system in Dade County, Florida, was investigated as part of a longterm study by the USGS in cooperation with the South Florida Water Management District, to describe the geology, hydrologic characteristics, and groundwater quality of the surficial aquifer system. Thirty-three test wells were drilled completely through the surficial aquifer system and into the underlying, relatively impermeable units of the Tamiami and Hawthorn Formations. Detailed lithologic logs were made from microscopic examination of rock cuttings and cores obtained from these wells. The logs were used to prepare geologic sections that show the lithologic variations, thickness of the lithologic units, and different geologic formations that comprise the aquifers system. (Author's abstract)
W89-04925

HYDROGEOLOGY OF THE EASTERN PART OF THE SALT RIVER VALLEY AREA, MARICOPA AND PINAL COUNTIES, ARIZONA,
Geological Survey, Tucson, AZ. Water Resources Div.
R. L. Laney, and M. E. Hahn.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, Co 80225. USGS Water Resources Investigations Report 86-4147. 1986. 4 sheets (maps), 12 fig, 45 ref.

Descriptors: *Maps, *Hydrogeology, *Arizona, *Salt River Valley, *Geohydrology, *Water resources data, *Potential water supply, Semiarid lands, Water supply development, Geology, Well yield, Groundwater management.

The Salt River Valley is a major agricultural and metropolitan area in semiarid south-central Arizona. Groundwater in the permeable sedimentary deposits underlying the area is a major water supply for agricultural, municipal, and industrial users. Groundwater levels have declined as much as 400 ft in recent years. Management of the remaining groundwater resources and their protection from contamination will require knowledge of the hydrogeologic framework and the water-bearing characteristics of the sedimentary units in the groundwater system. The rocks in the eastern part of the Salt River Valley are divided into six units--crystalline rocks, extrusive rocks, red units, lower unit, middle unit, and upper unit. The crystalline and extrusive rocks underlie the basin and form virtually impermeable hydrologic boundaries. The red, lower, middle and upper sedimentary units contain most of the groundwater. The red unit contains usable quantities of ground water, principally near Scottsdale, where it yields as much as 1,000 gallons/min (gpm) of water to wells. The lower unit, which makes up the largest volume of sedimentary deposits, consists mostly of mudstone, clay, silt, and evaporite deposits that may be as much as 10,000 ft thick in the central part of the basin. Wells tapping the mudstone, clay, silt yield 50 (gpm) or less but the conglomerate and the sand and gravel may yield as much as 3,500 gpm. The middle unit is the principal water-bearing unit in the basin and consists mostly of silt, siltstone, and silty sand and gravel. The unit is as much as 1,000 ft thick in the central part of the basin and as much as 700 ft is saturated. The unit will yield as much as 1,000 gpm where the saturated thickness is at least 500 ft. Locally, north of Mesa, the unit yields as much as 4,000 gpm. The upper unit is gravel, sand, and silt and is saturated only in a small area in the southwestern part of the basin. Where saturated, the unit may yield as much as 4,500 gpm. The upper unit transmits recharge derived from sheet flow, from flood flow in ephemeral streams, and from irrigation to the water table. (Author's abstract)
W89-04926

LOUISIANA HYDROLOGIC ATLAS MAP NO. 2: AREAL EXTENT OF FRESHWATER IN MAJOR AQUIFERS OF LOUISIANA,
Geological Survey, Baton Rouge, LA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W89-04928

WATER QUALITY IN THE LOWER PUYALLUP RIVER VALLEY AND ADJACENT UPLANDS, PIERCE COUNTY, WASHINGTON,
Geological Survey, Tacoma, WA. Water Resources Div.
For primary bibliographic entry see Field 5B.
W89-04930

GEOHYDROLOGY AND WATER QUALITY OF THE INYAN KARA, MINNELUSA, AND MADISON AQUIFERS OF THE NORTHERN BLACK HILLS, SOUTH DAKOTA AND WYOMING, AND BEAR LODGE MOUNTAINS, WYOMING,
Geological Survey, Rapid City, SD. Water Resources Div.
D. P. Kyllonen, and K. D. Peter.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, Co 80225. USGS Water Resources Investigations Report 86-4158. 1987. 61p, 22 fig, 7 tab, 43 ref.

Descriptors: *Water resources data, *Aquifer characteristics, *Groundwater, *Geohydrology, *Potential water supply, *Water quality, Groundwater movement, Well yield, Irrigation water, Drinking water, Water quality standards, Hardness, Iron, Fluoride, Sulfates, Manganese, Radiation.

The Inyan Kara, Minnelusa, and Madison aquifers are the principal sources of ground water in the northern Black Hills, South Dakota and Wyoming, and Bear Lodge Mountains, Wyoming. The aquifers are exposed in the Bear Lodge Mountains and the Black Hills and are about 3,000 to 5,000 ft below the land surface in the northeast corner of the study area. The direction of groundwater movement is from the outcrop area toward central South Dakota. Recharge is by infiltration of precipitation and streamflow is by springs and well withdrawals. All three aquifers yield water to flowing wells in some part of the area. Measured and reported well yields in each of the three aquifers exceed 100 gal/min (gpm). A well open to the Minnelusa Formation and the upper part of the Madison Limestone yielded more than 2,000 gpm. Water from the Inyan Kara aquifer may require treatment for gross alpha radiation, iron, manganese, sulfate, and hardness before use in public water systems. Water from the Minnelusa aquifer in the northern one-half of the study area may require treatment for sulfate and hardness before use in public water systems. Water from the Madison aquifer in the northern one-half of the study area may require treatment of fluoride, gross alpha radiation, sulfate, and hardness before use in public water systems. Water from the Minnelusa and Madison aquifers in the southern one-half of the study area, though very hard (more than 180 mg/L hardness as calcium carbonate), is suitable for public water systems and irrigation. Flow between the Minnelusa and the Inyan Kara aquifers appears to be insignificant, based on the results of a digital model results. The model indicated there may be significant recharge to the Minnelusa and Madison aquifers by leakage between these two aquifers and perhaps deeper aquifers. (Author's abstract)
W89-04932

SELECTED AQUIFER-TEST INFORMATION FOR THE COASTAL PLAIN AQUIFERS OF SOUTH CAROLINA,
Geological Survey, Columbia, SC. Water Resources Div.
W. R. Aucott, and R. Newcome.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, Co 80225. USGS Water Resources Investigations Report 86-4159. 1986. 30p, fig, 3 tab, 35 ref.

Descriptors: *Water resources data, *Aquifer testing, *Groundwater availability, *Aquifer characteristics, *Coastal aquifers, *South Carolina, *Pumping tests, *Well hydraulics, Well data, Transmissivity, Specific capacity.

Aquifer and well hydraulic characteristics were determined from more than 100 multiple-well and single-well aquifer tests in the Coastal Plain of South Carolina and tabulated by county. Multiple-well aquifer tests were analyzed by the This method for nonleaky aquifers and the Hantush-Jacob method for leaky aquifers. Single-well tests were analyzed by straight line solution techniques for drawdown and recovery tests. Specific-capacity data are presented for many areas where aquifer-test information is sparse. The characteristics determined are based largely on well performance tests conducted by well drillers and consulting engineers. Although use of this information has many limitations, it has value in establishing transmissivity and storage coefficient values for the Coastal Plain aquifers. (Peters-PTT)
W89-04933

DESCRIPTION OF THE HYDROLOGIC SYSTEM AND THE EFFECTS OF COAL MINING ON WATER QUALITY IN THE EAST FORK LITTLE CHARITON RIVER AND THE ALLUVIAL AQUIFER BETWEEN MACON AND HUNSTVILLE, NORTH-CENTRAL MISSOURI,
Geological Survey, Rolla, MO. Water Resources Div.
For primary bibliographic entry see Field 5B.
W89-04934

GULF COAST REGIONAL AQUIFER-SYSTEM ANALYSIS-A MISSISSIPPI PERSPECTIVE,
Geological Survey, Austin, TX. Water Resources Div.
H. F. Grubb.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4162. 1986. 22p, 6 fig, 2 tab, 43 ref.

Descriptors: *Water resources data, *Groundwater data, *Coastal aquifers, *Mississippi, *Groundwater recharge, *Alluvial aquifers, Saline water, Aquifers, Hydrogeology.

The Gulf Coast Regional Aquifer-System Analysis is a study of regional aquifers in sediments of mostly Cenozoic age in an area of about 230,000 sq mi in the Central Plain of Alabama, Arkansas, Florida, Illinois, Kentucky, Louisiana, Mississippi, Missouri, Tennessee, and Texas, and an additional 60,000 sq mi offshore. Three aquifer systems have been identified: the Mississippi embayment aquifer system, the Texas coastal uplands aquifer system, and the coastal lowlands aquifer system. These aquifer systems thicken from < 100 ft near their updip limit to thousands of ft gulfward toward their downdip limits. The Mississippi embayment aquifer system exceeds 5,000 ft in thickness in central Louisiana and in southwestern Mississippi. The thickest area in southwestern Mississippi underlies most of the six Mississippi counties, centered around Jefferson County. The greatest thick-

ness of the coastal lowlands aquifer system in Mississippi occurs in southern Hancock County where the system is composed of several individual aquifers and confining units. There are seven aquifers and three confining units in the Mississippi embayment aquifer system, five aquifers and two confining units in the Texas coastal uplands aquifer system, and five aquifers and two confining units in the coastal lowlands aquifer system. Most of the thicker parts of each aquifer system contain moderately saline to very saline water. Water in the Mississippi embayment aquifer system is moderately saline to very saline in most of a seven county area in southwestern Mississippi. About 9,600 million gal/day (gpd) of ground water was pumped from the aquifers in the study area during 1980. About 15% of that pumpage (or about 1,400 million gpd was in Mississippi, mostly from the Mississippi River Valley alluvial aquifer of the Mississippi embayment aquifer system. About 10% of the Mississippi pumpage, or 140 million gpd, was from the coastal lowlands aquifer system. Preliminary results from simulation of groundwater flow indicates that parts of Mississippi are major regional recharge areas for both the Mississippi embayment aquifer system and the coastal lowlands aquifer system. (Peters-PTT)
W89-04935

QUALITY OF WATER RESOURCES OF THE OUACHITA NATIONAL FOREST, ARKANSAS,
Geological Survey, Little Rock, AR. Water Resources Div.
E. F. Cole, and E. E. Morris.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4166. 1986. 1 sheet (map), 3 fig, 3 tab, 15 ref.

Descriptors: *Water resources data, *Water quality, *Ouachita National Forest, *Hydrologic data collections, *Maps, Potential water supply, Groundwater, Surface water.

Surface water and groundwater quality was documented in the Ouachita National Forest by collecting surface water quality data at 15 points and groundwater quality data at 11 sites from April 1984 through August 1985. The data were compared to drinking water standards and the results are tabulated. Surface water in the Ouachita National Forest is relatively abundant. It is low in mineralization and chemically suitable for most uses with minimal treatment. Groundwater is relatively scarce. The low yields of wells limit the use of groundwater primarily to domestic use. The water is chemically suitable for most purposes but may require treatment for the removal of iron. (Peters-PTT)
W89-04938

SELECTED HYDROLOGIC AND PHYSICAL PROPERTIES OF MESOZOIC FORMATIONS IN THE UPPER COLORADO RIVER BASIN IN ARIZONA, COLORADO, UTAH, AND WYOMING--EXCLUDING THE SAN JUAN BASIN,
Geological Survey, Salt Lake City, UT. Water Resources Div.
J. F. Weigel.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4170. 1987. 68p, 4 fig, 6 tab, 24 ref.

Descriptors: *Geohydrology, *Water resources data, *Colorado, *Utah, *Wyoming, *Hydrologic data collections, *Colorado River Basin, Data interpretation, Testing procedures, Aquifer testing, Specific capacity, Hydraulic conductivity.

Data for hydrologic and physical properties of Mesozoic formations in the Upper Colorado River Basin, excluding the San Juan Basin, have been collected by government agencies, private industry, property owners, and other sources. These data were compiled and analyzed so that they would be available for use by hydrologists, earth scientists, planners, and others. Five methods of data analysis are discussed. The results of these five methods are not directly comparable because of differences in the volume of an aquifer represented by each method. Aquifer tests represent the largest volume of an aquifer, specific capacity and drill-stem tests represent a smaller volume, slug-injection tests represent a still smaller volume, and laboratory tests represent the smallest volume. Because they represent large volumes of an aquifer, aquifer tests were considered to give the best estimates of hydrologic characteristics. Laboratory data for permeability to air and hydraulic conductivity were determined to be related by a simple power function. (Author's abstract)
W89-04940

GEOHYDROLOGY AND POTENTIAL HYDROLOGIC EFFECTS OF UNDERGROUND COAL MINING IN THE RAPID CREEK BASIN, MESA COUNTY, COLORADO,
Geological Survey, Denver, CO. Water Resources Div.
For primary bibliographic entry see Field 4C.
W89-04942

GEOHYDROLOGIC RECONNAISSANCE OF A GROUND-WATER CONTAMINATION PROBLEM IN THE ARGONNE ROAD AREA NEAR SPOKANE, WASHINGTON,
Geological Survey, Tacoma, WA. Water Resources Div.
For primary bibliographic entry see Field 5B.
W89-04943

RECONNAISSANCE OF HYDROLOGY, LAND USE, GROUND-WATER CHEMISTRY, AND EFFECTS OF LAND USE ON GROUND-WATER CHEMISTRY IN THE ALBUQUERQUE-BELEN BASIN, NEW MEXICO,
Geological Survey, Albuquerque, NM. Water Resources Div.
For primary bibliographic entry see Field 5B.
W89-04944

THICKNESS AND HYDROGEOLOGY OF AQUIFERS AND CONFINING UNITS BELOW THE UPPER GLACIAL AQUIFER ON LONG ISLAND, NEW YORK,
Geological Survey, Syosset, NY. Water Resources Div.
J. Soren, and D. L. Simmons.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4175. 1987.3 sheets (maps), 10 fig, 2 tab, 23 ref.

Descriptors: *Aquifer characteristics, *Geohydrology, *Water supply, *Water resources data, *New York, *Pumpage, *Long Island, Groundwater reservoirs, Hydraulic conductivity, Glacial aquifers, Water use.

Three extensive unconsolidated sand and gravel aquifers on Long Island lie between the island's upper glacial aquifer and its southward-dipping crystalline bedrock surface. The island's aquifers have been heavily pumped, mainly for public-water supply, but most of this pumpage since the 1960's has come from below the upper glacial aquifer because the upper aquifer has been increasingly contaminated by substances introduced through the land surface. In 1984, an average of 370 million gal/day (gpd) was pumped from the groundwater reservoir, 80% (298 million gpd) of which was from aquifers below the upper glacial aquifer. The artesian Lloyd aquifer, confined between bedrock and the overlying Raritan clay, is the basal unit in Long Island's groundwater reservoir. The Lloyd underlies nearly all of the island and has a maximum thickness of about 550 ft. It is a minor aquifer; public-supply pumpage from the Lloyd in 1984 averaged 18 million gpd. The Magothy aquifer overlies the Raritan clay beneath most of the island and attains a maximum thickness of 1,050 ft. The Magothy has been the principal source of public water supply since 1960's, and public-supply pumpage in 1984 averaged 278 million gpd. The Jameco aquifer occurs only in buried valleys that were cut into the Magothy deposits in the extreme western part of Long Island; thus, the aquifer has good lateral and vertical hydraulic continuity with the Magothy. The Jameco attains a maximum thickness of 200 ft. Jameco deposits have greater average hydraulic conductivity than the Magothy and are considered to form a broad, highly conductive local stringer in the upper part of the Magothy. The Jameco is a minor aquifer; in 1984, average public-supply pumpage was 2 million gpd. In the southern part of the island, the Magothy-Jameco system is artesian, overlain by the Gardiners Clay in the western part of the island, and by the Gardiners Clay and the Monmouth greensand in the eastern two thirds. North of the Gardiners-Monmouth limits, the Magothy is 'leaky' vertically because the clay beds within it are discontinuous; there, its response to pumping stresses is similar to that of the unconfined overlying upper glacial aquifer, with which it is in hydraulic continuity to various degrees. (Author's abstract)
W89-04945

SHALLOW GROUND-WATER CONDITIONS, TOM GREEN COUNTY, TEXAS,
Massachusetts Inst. of Tech., Cambridge. Microsystems Technology Labs.
J. N. Lee.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4177, 1986. 88p, 14 fig, 7 tab, 20 ref.

Descriptors: *Water chemistry, *Groundwater quality, *Groundwater pollution, *Groundwater, *Texas, Dissolved solids, Coliforms, Streptococci, Heavy metals, Bacteria, Nitrates, Sulfates, Water table, Chlorides, Selenium, Manganese.

Current (1983) water levels in Tom Green County, Texas probably are higher than normal due to the above-normal precipitation during 1980-81. Ground water in Tom Green County commonly is very hard (greater than 180 mg/L as calcium carbonate), and chemical types vary in the aquifers and in different parts of the county. The concentrations of dissolved materials were as follows: solids 200 to 3,000 mg/L; dissolved-chloride, 40 to 1000 mg/L; dissolved-sulfate 25 to 600 mg/L; dissolved-nitrate (from eight wells), 2 to 37 mg/L. Five of the nitrate samples exceeded the EPA maximum level of 10 mg/L. Of the eight water samples analyzed for minor elements, two exceeded the maximum contaminant level for selenium, and one for manganese; in three wells analyzed, no pesticides were detected. Two groups of groundwater samples were tested for bacteria in April and August 1983. Water samples from seven wells were common to both groups, and samples tested in August contained more bacteria. Counts of fecal-coliforms ranged from 0 to 26 colonies per 100 ml with most less than 5 colonies per 100 ml. Counts of fecal-streptococci ranged from 0 to 400 colonies per ml with most less than 20 colonies per 100 ml. Using dissolved-solids concentrations as an indicator, historical and current (1983) water-quality records were compared to determine if any changes in water quality had occurred. The quality of water from Cretaceous rocks underlying the Edwards Plateau has not changed significantly; this water is the least mineralized ground water in the county. The quality of water from the Arroyo and Bullwagon aquifers in the eastern most part of the county also has not changed significantly; dissolved-solids concentrations range from 1500 to 2000 mg/L. In the remainder of the county, dissolved-solids concentrations have increased from 10 to 500 mg/L in ground water along the river valleys and in the Lipan Flat area and increases of 500 to 1100 mg/L have occurred in ground water southeast of San Angelo, west of Twin Buttes Reservoir, and about 10 mi east of San Angelo. Locally, dissolved-solids concentrations have increased by as much as 4530 mg/L in water from individual wells. Pollution from oil-field activities may affect the quality of water in some isolated wells and in some areas in the county. No historical records are available for determining any changes in pesticides, minor elements, or bacteria. (Author's abstract)
W89-04947

WATER-LEVEL MAPS OF THE ALLUVIAL AQUIFER IN EASTERN ARKANSAS, 1985,
Geological Survey, Little Rock, AR. Water Resources Div.
M. Plafcan, and D. T. Fugitt.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4178, 1986. 1p (map), 6 fig, 10 ref.

Descriptors: *Maps, *Alluvial aquifers, *Hydrologic maps, *Groundwater level, *Arkansas, Aquifers.

Maps shown in this report show the potentiometric surface of the alluvial aquifer before and after the pumping season of 1985, the depth-to-water in the spring of 1985, and the change in water levels between the spring of 1980 and the spring of 1985. Hydrographs showing long-term water-level changes in the alluvial aquifer are also included. (Rubinstein-PTT)
W89-04948

GROUND-WATER RECHARGE RATES IN NASSAU AND SUFFOLK COUNTIES, NEW YORK,
Geological Survey, Syosset, NY. Water Resources Div.
D. S. Peterson.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4181, 1987. 19p, 5 fig, 3 tab, 19 ref.

Descriptors: *Groundwater recharge, *Long Island, Precipitation rate, Evapotranspiration, Runoff.

Groundwater is the sole source of freshwater in Nassau and Suffolk Counties on Long Island; therefore, the rate at which precipitation replenishes the groundwater system may affect future water supplies in some areas. Annual precipitation on Long Island averages 45 inches per year, but less than 23 inches, or 50%, recharges the groundwater system. (Recharge is precipitation that percolates to the ground-water system naturally; it does not include water from stormwater basins or injection wells.) The rate of recharge varies locally and ranges from 29% to 57% of precipitation, depending on land use, season, and amount of storm sewering in the area. Recharge was calculated by subtracting evapotranspiration and direct runoff values from known precipitation values. Evapotranspiration was calculated by the Thornwaite and Mather method, and direct runoff rates to streams were calculated from streamflow records and size of known storm-sewer service areas. This report includes maps that depict precipitation, evapotranspiration, and rates of natural recharge in Nassau and Suffolk Counties for use in future hydrologic studies on Long Island. (Author's abstract)
W89-04951

CHARACTERISTICS AND PROPERTIES OF THE BASIN-FILL AQUIFER DETERMINED FROM THREE TEST WELLS WEST OF ALBUQUERQUE, BERNALILLO COUNTY, NEW MEXICO,
Geological Survey, Albuquerque, NM. Water Resources Div.
For primary bibliographic entry see Field 4B.
W89-04952

ASSESSMENT OF GROUND-WATER CONTAMINATION AT WURTSMITH AIR FORCE BASE, MICHIGAN, 1982-85,
Geological Survey, Lansing, MI. Water Resources Div.
For primary bibliographic entry see Field 5B.
W89-04953

THREE-DIMENSIONAL MODEL SIMULATION OF TRANSIENT GROUND-WATER FLOW IN THE ALBUQUERQUE-BELEN BASIN, NEW MEXICO,
Geological Survey, Albuquerque, NM. Water Resources Div.
J. M. Kernodle, R. S. Miller, and W. B. Scott.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4194, 1987. 86p, 46 fig, 6 tab, 24 ref.

Descriptors: *Model studies, *New Mexico, *Groundwater movement, *Watershed models, *Alluvial aquifers, *Simulation analyses, Hydraulic conductivity, Flood plains, Rio Grande River.

A three-dimensional digital model that simulates transient flow in the alluvial aquifer system underlying the Albuquerque-Belen Basin, New Mexico, was constructed as part of a regional aquifer study of the southwest alluvial basins. The model simulates hydraulic heads and changes in hydraulic heads for 1907 to 1979. Hydraulic-conductivity values used in the accepted model range from 0.25 ft/day in part of the Santa Fe Group to 50 ft/day in the fluvial deposits in the Rio Grande flood plain. The majority of the basin-fill material of the Santa Fe group of Tertiary and Quaternary age was modeled as having a horizontal hydraulic conductivity of either 30 or 40 ft/day. The simulated specific storage of the aquifer was 0.000001/ft and the simulated specific yield was 0.10. The aquifer was simulated as being vertically anisotropic with a ratio of vertical to horizontal hydraulic conductivity of 1:500. Simulations for 1976-79 indicated that of the 100,000 acre-ft of groundwater withdrawn annually from the basin-fill deposits outside of the Rio Grande flood plain, 68% was obtained from recharge around the basin margin, depletion of streams that are tributary to the Rio Grande, and the stream-aquifer system in the Rio Grande flood plain. Depletion of aquifer storage accounted for 25% of the groundwater supply to wells outside of the flood plain, and the remaining 7% was obtained by induced groundwater inflow from the Santo Domingo Basin. The model displayed an acceptable performance throughout the period of simulation. However, by the end of the simulation period, 1979, the portrayal of the Rio Grande flood-plain system as a specified hydraulic-head boundary was having adverse effects on the simulation. (Author's abstract)
W89-04957

DIRECTIONS AND RATES OF GROUNDWATER MOVEMENT IN THE VICINITY OF KESTERSON RESERVOIR, SAN JOAQUIN VALLEY, CALIFORNIA,
Geological Survey, Sacramento, CA. Water Resources Div.
R. J. Mandle, and A. L. Kontis.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4196, 1986. 57p, 18 fig, 6 tab, 22 ref.

Descriptors: *Model studies, *California, *Groundwater movement, *Watershed models, *Simulation analyses, *Groundwater recharge, Evapotranspiration, Reservoirs, San Joaquin Valley.

A three-dimensional groundwater flow model was used to simulate groundwater flow for a 124 sq mi area in the vicinity of Kesterson Reservoir in the San Joaquin Valley, California. Available data were used to calculate a probable range of groundwater flow rates, but calibration and sensitivity analysis were not done for this model. Flow directions, as inferred from measured groundwater levels and simulated hydraulic heads from all model simulations, indicate that regional groundwater flow is from the south to the north. Kesterson Reservoir acts as a recharge mound superimposed on the regional-flow system. Groundwater moves in the horizontal and vertical direction away from Kesterson Reservoir. Mud and Salt Sloughs act as groundwater discharge areas. Simulated groundwater flow from Kesterson Reservoir did not flow beyond these sloughs. Groundwater from west of Mud Slough seems to flow west toward Los Banos Creek and east toward Mud Slough. Groundwater that travels toward Salt Slough from Kesterson Reservoir probably is lost by evapotranspiration near the surface before reaching Salt Slough. Groundwater between Salt Slough and the San Joaquin River seems to flow north and toward Salt Slough and the San Joaquin River. The canals and duck ponds generally act as sources of groundwater recharge. A method was developed for determining flow directions and distance traveled in three dimensions for discrete time increments using simulated groundwater fluxes. Simulated average horizontal pore velocities away from Kesterson range less than 0.01 to 140 ft/year. The simulated average vertical pore velocities range from 0.01 to 14.7 ft/year. (Author's abstract)
W89-04958

DESCRIPTION AND COMPARISON OF SELECTED MODELS FOR HYDROLOGIC ANALYSIS OF GROUND-WATER FLOW, ST. JOSEPH RIVER BASIN, INDIANA,
Geological Survey, Indianapolis, IN. Water Resources Div.
J. G. Peters.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4199, 1987. 125p, 42 fig, 17 tab, 109 ref.

Descriptors: *Groundwater movement, *Watershed models, *Simulation analysis, *Indiana, *Model studies, *Irrigation effects, *Glacial aquifers, River basins, Geohydrology, Comparison studies.

The Indiana Department of Natural Resources (IDNR) is developing water-management policies designed to assess the effects of irrigation and other water uses on water supply in the basin. In support of this effort, the USGS, in cooperation with IDNR, began a study to evaluate appropriate methods for analyzing the effects of pumping on ground-water levels and streamflow in the basin's glacial aquifer systems. Four analytical models describe drawdown for a nonleaky, confined aquifer and fully penetrating well; a leaky, confined aquifer and fully penetrating well; a leaky, confined aquifer and partially penetrating well; and an unconfined aquifer and partially penetrating well. Analytical equations, simplifying assumptions, and methods of application are described for each model. In addition to these four models, several other analytical models were used to predict the effects of ground-water pumping on water levels in the aquifer and on streamflow in local areas with up to two pumping wells. Analytical models for a variety of other hydrogeologic conditions are cited. A digital ground-water flow model was used to describe how a numerical model can be applied to a glacial aquifer system. The numerical model was used to predict the effects of six pumping plans in 46.5 sq mi area with as many as 150 wells. Water budgets for the six pumping plans were used to estimate the effect of pumping on streamflow reduction. Results of the analytical and numerical models indicate that, in general, the glacial aquifers in the basin are highly permeable. Radial hydraulic conductivity calculated by the analytical models ranged from 280 to 600 ft/day, compared to 210 and 360 ft/day used in the numerical model. Maximum seasonal pumping for irrigation produced maximum calculated drawdown of only one-fourth of available drawdown and reduced streamflow by as much as 21%. Analytical models are useful in estimating aquifer properties and predicting local effects of pumping in areas with simple lithology and boundary conditions and with few pumping wells. Numerical models are useful in regional areas with complex hydrogeology with many pumping wells and provide detailed water budgets useful for estimating the sources of water in pumping simulations. Numerical models are useful in constructing flow nets. The choice of which type of model to use is also based on the nature and scope of questions to be answered and on the degree of accuracy required. (Author's abstract)
W89-04961

CHEMICAL EFFECTS OF HIGHWAY RUNOFF ON THE SURFICIAL AQUIFER, BROWARD COUNTY, FLORIDA,
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 5B.

W89-04962

RECONNAISSANCE OF GEOHYDROLOGIC AREAS AND IN 1981 LOW-FLOW CONDITIONS, WITHLACOOCHEE RIVER BASIN, SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT,
Geological Survey, Tallahassee, FL. Water Resources Div.
J. O. Kimrey, and W. Anderson.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4203, 1987. 53p, 31 fig, 10 tab, 16 ref.

Descriptors: *Surface-groundwater relations, *Floridan Aquifer, *Water resources data, *Unconfined aquifer, *Groundwater recharge, *Florida, *Low flow, Drainage area, Aquifers, Withlacoochee River basin, Geohydrology.

The Withlacoochee River Basin of the Southwest Florida Water Management District is a management area of about 2030 sq mi in west-central Florida containing large reserves of potable water in the Upper Floridan aquifer. Results of reconnaissance test drilling indicate that the Upper Floridan aquifer may be treated as an unconfined aquifer in the management area which allows it to be divided into two types of geohydrologic areas: (1) areas of high recharge, and (2) areas of moderate recharge. Conceptually, the source of water to well fields in areas of high recharge would largely be natural recharge, whereas, in areas of moderate recharge, a significant part of the source of water to well fields would be induced downward leakage, or capture, of surface and near-surface water. The Withlacoochee River Basin of the Southwest Florida Water Management District is drained almost entirely by the Withlacoochee River and its tributaries. Field data were collected from April 13 through August 17, 1981, to document extremely low streamflow conditions. Conditions in the upper half of the drainage basin were found to be the most severe of record. On July 7, 1981, the total net runoff from the upper half of the basin was observed to be only 0.1 cu ft/sec. Low-flow conditions in the lower half of the drainage basin, however, were less severe than during the record low period of 1956. (Author's abstract)
W89-04964

HYDRAULIC CHARACTERISTICS OF UPPER CRETACEOUS AND LOWER TERTIARY CLASTIC AQUIFERS--EASTERN ALABAMA, GEORGIA, AND WESTERN SOUTH CAROLINA,
Geological Survey, Doraville, GA. Water Resources Div.
R. E. Faye, and K. W. McFadden.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4210, 1986. 22p, 1 plate, 4 fig, 3 tab, 48 ref.

Descriptors: *Aquifers, *Geohydrology, *Storage coefficient, *Transmissivity, *Alabama, *Georgia, *South Carolina, Regression analysis.

Transmissivity and storativity data for the clastic sediments of the northern Coastal Plain of eastern Alabama, Georgia, and western South Carolina were compiled and evaluated. Transmissivity values ranged from less than 100 to about 35,000 ft sq/day; storativity ranged from about 0.00002 to 0.0002. Data for lower Tertiary sediments represented by the Clayton and Tallahatta Formations and equivalent Midwayan and Claibornian sediments are listed for 17 sites. Transmissivity values of these sediments range from about 500 to 10,000 ft sq/day. Transmissivity values for the Cretaceous Providence Sand and Cusseta Sand and equivalent Navarroan-Tayloran sediments are listed for 10 sites and range from about 500 to 34,000 ft sq/day. Transmissivity values for the Blufftown and Eutaw Formations and equivalent Cretaceous Tayloran-Austinian sediments are listed for 16 sites and range from about 3000 to 35,000 ft sq/day. Transmissivity of the Cretaceous Tuscaloosa Formation and equivalent Eaglefordian sediments is listed for 5 sites and ranges from about 30 to 500 ft sq/day. Estimates of transmissivity based on well specific capacity were computed by using the modified nonequilibrium formula and linear regression analysis. The regression analysis was based on log-transformed paired transmissivity and specific-capacity data at 48 pumping wells. The regression model provided better estimates of transmissivity than the modified nonequilibrium formula. (Author's abstract)
W89-04966

GROUND-WATER PUMPAGE FROM THE COLUMBIA PLATEAU REGIONAL AQUIFER SYSTEM, OREGON, 1984,
Geological Survey, Portland, OR. Water Resources Div.
For primary bibliographic entry see Field 6D.
W89-04967

WATER-TABLE CONTOURS AND DEPTH TO WATER IN THE SOUTHEASTERN PART OF THE SWEETWATER RIVER BASIN, CENTRAL WYOMING, 1982,
Geological Survey, Cheyenne, WY.
For primary bibliographic entry see Field 7C.
W89-04969

STREAMFLOW GAIN AND LOSS OF SELECTED STREAMS IN NORTHERN ARKANSAS,
Geological Survey, Little Rock, AR. Water Resources Div.
For primary bibliographic entry see Field 7C.
W89-04970

POLLUTION OF GROUND WATER BY NUTRIENTS AND FECAL COLIFORMS FROM LAKESHORE SEPTIC TANK SYSTEMS,
New York State Dept. of Health, Albany. Wadsworth Center for Labs. and Research.
For primary bibliographic entry see Field 5B.
W89-04978

STOCHASTIC ANALYSIS OF PATHS OF HIGH HYDRAULIC CONDUCTIVITY IN POROUS MEDIA,
Notre Dame Univ., IN. Dept. of Civil Engineering.
S. E. Silliman, and A. L. Wright.
Water Resources Research WRERAO, Vol. 24, No. 11, p 1901-1910, November 1988. 11 fig, 4 tab, 32 ref. Nuclear Regulatory Commission contract NRC-04-84-275.

Descriptors: *Porous media, *Hydraulic conductivity, *Groundwater movement, *Hydrodynamics, *Mathematical models, Monte Carlo method, Arizona.

Recent investigations of heterogeneity within subsurface media have shown the importance of understanding the structure of hydraulic conductivity fields when considering either flow or transport within porous media. A Monte Carlo approach was used to investigate the existence and structure of continuous paths of high hydraulic conductivity within low conductivity media. The rock mass is modeled as a discretized grid of elements, each element characterized by a single value for the hydraulic conductivity. By transforming the hydraulic conductivity utilizing the cumulative distribution function of the conductivity, a new random variable is obtained which is uniformly distributed in the range (0,1). Utilizing this parameter, one can locate the path (termed the extreme path) which (1) connects two specified faces of the simulation grid and (2) contains the maximum value for the minimum conductivity along all such paths. The transform of this maximized minimum is termed the extreme path value. Grids are analyzed which are characterized either by (1) independence between grid elements, (2) correlation between grid elements, or (3) conditioning on field values obtained from a site in southern Arizona. For all grids analyzed, there will exist, on average, at least one path crossing the grid along which the hydraulic conductivity is everywhere greater than the effective conductivity of the medium. When the minimum conductivity along such extreme paths is analyzed, it is observed that the expected value of this minimum conductivity increases with correlation. Conditioning simulations on field values resulted in a decrease in the estimation variance of the minimum conductivity. (Author's abstract)
W89-05059

EFFECTIVE PERMEABILITY AND DISPERSION IN LOCALLY HETEROGENEOUS AQUIFERS,
Technische Hogeschool Twente, Enschede (Netherlands).
A. D. Poley.
Water Resources Research WRERAO, Vol. 24, No. 11, p 1921-1926, November 1988. 4 fig, 13 ref, append.

Descriptors: *Permeability, *Path of pollutants, *Aquifers, *Hydraulic permeability, *Hydrodynamics, *Groundwater movement, Model studies, Statistics, Stochastic hydrology, Mathematical models.

The global effective permeability and hydrodynamic dispersion tensors due to steady flow in locally heterogeneous and statistically anisotropic aquifers are analyzed using the self-consistent approximation. For small perturbations the results for the statistically anisotropic case were consistent with those derived using stochastic continuum theory. However, for larger perturbations the stochastic continuum theory has not yet produced rigorous results that can be compared with those in this paper. (Author's abstract)
W89-05061

DETERMINATION OF FLUID FLOW PROPERTIES FROM THE RESPONSE OF WATER LEVELS IN WELLS TO ATMOSPHERIC LOADING,
Geological Survey, Menlo Park, CA.
S. Rojstaczer.
Water Resources Research WRERAO, Vol. 24, No. 11, p 1927-1938, November 1988. 10 fig, 2 tab, 25 ref, append.

Descriptors: *Wells, *Water level, *Confined aquifers, *Groundwater movement, *Hydraulic diffusivity, *Atmospheric pressure, Flow characteristics, Theoretical analysis, Aquifers.

The water level in a well that taps a partially confined aquifer is often sensitive to atmospheric loading. The magnitude and character of this response is partly governed by the well radius, the lateral hydraulic diffusivity of the aquifer, the thickness and vertical pneumatic diffusivity of the unsaturated zone, and the thickness and vertical hydraulic diffusivity of the saturated zone overlying the aquifer. These key elements can be combined into 5 dimensionless parameters that partly govern the phase and attenuation of the response. In many cases, the response of a well to atmospheric loading can be broken up into a high-, intermediate-, and low-frequency response. The high-frequency response is governed largely by the well radius and lateral diffusivity of the aquifer. The intermediate-frequency response is governed by the loading efficiency of the aquifer. The low-frequency response is governed by the vertical pneumatic diffusivity and thickness of the unsaturated zone and the vertical hydraulic diffusivity and thickness of the saturated material above the aquifer. Cross-spectral estimation is used to fit the response to atmospheric loading of three water wells to the theoretical curves in order to yield estimates of three of the key dimensionless parameters. The theoretical response can be used in conjunction with the observed response of water wells as a function of frequency to yield estimates or place bounds on the fluid flow parameters within the aquifer, confining layer and unsaturated zone. In low permeability environments the response of water wells to atmospheric loading may prove useful in estimating aquifer permeability. (Sand-PTT)
W89-05062

NEW FUNCTIONAL FORM FOR THE DISPERSIVE FLUX IN POROUS MEDIA,
California Univ., Livermore. Lawrence Livermore Lab.
A. F. B. Tompson.
Water Resources Research WRERAO, Vol. 24, No. 11, p 1939-1947, November 1988. 4 fig, 35 ref. Department of Energy Contract W-7405-Eng-48.

Descriptors: *Soil water, *Model studies, *Porous media, *Dispersive transport, *Groundwater movement, Mathematical models.

A second-order model for local dispersive transport in porous media was simplified to yield a new, closed-form relationship for the dispersive flux. In situations characterized by negligible velocity gradients, the flux can generally be represented as a convolution or 'memory' integral over time of previous concentration gradients. The strength of this memory is controlled by an exponential weighting factor related to the magnitudes of the velocity and local molecular diffusive flux. The form of this result is consistent with other models of diffusive and dispersive transport phenomena over various spatial scales. In circumstances where the memory strength is small, the integral can be simplified and cast in the form of a standard Fickian relationship with apparent time-dependent dispersivity functions that grow to finite, asymptotic values. This specific formulation can be manipulated to yield a one-equation transport balance law in the form of a telegraph equation. Nonphysical effects, such as spurious upstream dispersion and instantaneous propagation of mass to extremely distant points predicted with a Fickian law, are reduced or eliminated. Although the importance of the new result in transport simulations will depend on the spatial and temporal scales of interest, it should provide some insight in the interpretation and design of new experiments. (Author's abstract)
W89-05063

THEORETICAL ANALYSIS OF SEEPAGE FLOW OF THE CONFINED GROUNDWATER INTO THE LAKE BOTTOM WITH A GENTLE SLOPE,
Nara Univ. of Education (Japan). Dept. of Earth Science.
Y. Fukuo, and I. Kaihotsu.
Water Resources Research WRERAO, Vol. 24, No. 11, p 1949-1953, November 1988. 6 fig, 2 tab, 7 ref. Ministry of Education, Science and Culture, Grant-in-Aid for Scientific Research 58030007.

Descriptors: *Surface-groundwater relations, *Lake bottom springs, *Hydrologic budget, *Confined aquifers, *Lakes, *Groundwater movement, *Seepage, Theoretical analysis.

In Japan, a new interest has been shown in the specific discharge of groundwater from a lake bottom in order to elucidate its influence on the quality and quantity of lake water. Using conformal mapping techniques, steady two-dimensional groundwater flow is described analytically in an idealized confined aquifer, which extends infinitely with uniform thickness and constant inclination and is exposed to the lake bottom surface with a gentle slope. The techniques enable analytical calculation of the head and stream functions of groundwater in the aquifer and also the distribution of specific discharge at lake bottom surface. The calculations show that most of the aquifer water flows into the lake through the upper part of the surface of contact between lake and aquifer. This analysis may be useful in the evaluation of the role of groundwater seepage in the water balance of large lakes. (Author's abstract)
W89-05064

ACID PRECIPITATION AND GROUNDWATER CHEMISTRY AT THE TURKEY LAKES WATERSHED,
National Hydrology Research Inst., Saskatoon (Saskatchewan).
For primary bibliographic entry see Field 5B.
W89-05087

ALUMINUM CONTAMINATION OF GROUNDWATER: SPRING MELT IN CHALK RIVER AND TURKEY LAKES WATERSHEDS--PRELIMINARY RESULTS,
National Hydrology Research Inst., Saskatoon (Saskatchwan). Ground Water Div.
For primary bibliographic entry see Field 5B.
W89-05088

EFFECT OF WATERTABLE DEPTH AND WATERLOGGING ON CROP YIELD,
Bologna Univ. (Italy). Inst. of Agronomy and Field Crops.
For primary bibliographic entry see Field 3F.
W89-05109

EFFECT OF WATERTABLE ON YIELD AND ROOT DEPTH OF WINTER WHEAT IN THE FRENCH WEST CENTRAL ATLANTIC MARSHLANDS,
Institut National de la Recherche Agronomique, Paris (France).
For primary bibliographic entry see Field 3F.
W89-05110

EFFECT OF SWELLING AND SHRINKAGE ON THE CALCULATION OF WATER BALANCE AND WATER TRANSPORT IN CLAY SOILS,
Institute for Land and Water Management Research, Wageningen (Netherlands).
For primary bibliographic entry see Field 2G.
W89-05125

DESCRIPTION OF A REGIONAL GROUNDWATER FLOW MODEL SIMGRO AND SOME APPLICATIONS,
Institute for Land and Water Management Research, Wageningen (Netherlands).
E. P. Querner.
Agricultural Water Management AWMADF, Vol. 14, No. 1-4, p 209-218, August 1988. 4 fig, 4 tab, 7 ref.

Descriptors: *Groundwater movement, *Soil water, *Hydrologic models, *Saturated flow, *Surface flow, *Unsaturated flow, *Regional analysis, Finite element method, Soil water, Computer models, Aeration zone, Root zone, Groundwater level, Land use, Water management, Surface water, Sprinkling, Regional planning.

Regional water management plays an important rule in agricultural production and in nature reserves. The groundwater flow model, SIMGRO, simulates the flow of water in the saturated zone, the unsaturated zone and the surface water system. The model is constructed in such a manner that it is accurate enough without requiring many input data and much computer time. The saturated zone consists of a quasi-three dimensional finite element model with an implicit calculation scheme. The unsaturated zone is modeled by means of two reservoirs, one for the root zone and one for the subsoil. Storage of water in the root zone is considered with extractions and inflows. From the water balance of the subsoil the height of the phreatic surface is calculated with a storage coefficient. The unsaturated zone is considered per land use (agricultural crops, natural vegetations) on a subregional level. Subregions are chosen in such a way that they have relatively homogeneous soil properties and hydrological conditions. The surface water system of a subregion, in reality a network of small channels, is considered as one reservoir with criteria for, among others, water supply, discharge characteristics, water level control and extractions for sprinkling. The usefulness of the model is demonstrated with the estimation of the effect of a groundwater extraction on a regional level and the impact of sprinkling. The regional model is also used in connection with a crop production model, to quantify these regional water management aspects in terms of crop production and cost benefits. (Author's abstract)
W89-05127

CHANGE OF CHARACTERISTICS OF A GRANULAR AQUIFER IN AGRICULTURAL AREAS,
Calgary Univ. (Alberta). Dept. of Geology and Geophysics.
L. C. Goldenberg.
Agricultural Water Management AWMADF, Vol. 14, No. 1-4, p 329-338, August 1988. 4 fig, 1 tab, 21 ref.

Descriptors: *Surface-groundwater relations, *Aquifer characteristics, *Aquifer testing, *Agricultural hydrology, *Groundwater, Sand aquifers, Conductivity, Variability, Geohydrology, Israel, Isotope studies.

In areas of intensive agriculture, man's activities disturb the physical and chemical equilibria in aquifers. Changes in properties occur that may cause reduction of the transport time of water and dissolved salts in the vadose zone; creation of a variety of chemically and isotopically different types of water in the saturated zone; and difficulty in accurately characterizing the properties of the groundwater. Observations of the chemical and isotopic characteristics of 84 producing wells in the granular coastal aquifer of Israel reveal frequent and sharp fluctuations in water characteristics geographically, vertically and through time. In samples taken from Revadim well situated in an area of intensive agriculture, electrical conductivity fluctuated between 500 to 2700 micro mhos/cm; Cl(-) from 200 to 600 mg/L; Tritium from 2 to 30; delta Deuterium from -2 to -12 ppt; and delta 0-18 from -1 to -4.5 ppt. Mechanisms are suggested for the observed changes. It is concluded that characterization of groundwater properties in an aquifer system affected by agriculture is difficult. (Author's abstract)
W89-05138

GROUNDWATER RECHARGE IN SCHLESWIG-HOLSTEIN (WEST GERMANY),
Kiel Univ. (Germany, F.R.). Inst. fuer Pflanzenernaehrung und Bodenkunde.
M. Zingk.
Agricultural Water Management AWMADF, Vol. 14, No. 1-4, p 339-343, August 1988. 2 fig, 4 tab, 7 ref.

Descriptors: *Groundwater recharge, *Surface-groundwater relations, *Aquifer characteristics, Aquifer testing, West Germany, Evapotranspiration forests.

Groundwater recharge in Schleswig-Holstein was investigated on 13 plots. The plots differed with respect to parent materials (boulder, clay, glacial sandurs and marine sediments), land use (woodland, arable land, permanent grassland) and vegetation (beech, oak, spruce and alder forests, also different crops). Precipitation was measured every two weeks and the evapotranspiration, effective root zone and groundwater recharge were determined. Groundwater recharge strongly depends on climate, land use and vegetation, its long-term average being between 100 and 350 mm in the case of forest and between 250 and 400 mm for arable crops and grassland. (Author's abstract)
W89-05139

HYDROCHEMISTRY OF RICH FEN AND WATER MANAGEMENT,
Institute for Land and Water Management Research, Wageningen (Netherlands).
For primary bibliographic entry see Field 2H.
W89-05145

TONGALA GROUNDWATER PUMPING/REUSE PROJECT: A PILOT STUDY FOR GROUNDWATER TABLE CONTROL IN THE SHEPPARTON REGION IN NORTHERN VICTORIA,
Victoria Dept. of Agriculture and Rural Affairs, Tatura (Australia). Inst. for Irrigation and Salinity.
For primary bibliographic entry see Field 4B.
W89-05153

UNDERGROUND WATERS: FUNCTIONAL SUB-UNITS OF AN EXSURGENCE KARSTIC SYSTEM, AND EXCHANGES WITH THE SUR-

FACE ENVIRONMENT. REFLECTIONS ON THE CHARACTERIZATION OF NATURAL AQUATIC GROUNDWATER SYSTEMS,
Lyon-1 Univ., Villeurbanne (France). Lab. d'Ecologie des Eaux Douces.
J. Gibert.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IVTLAP, Vol. 23, No. 2, p 1090-1096, August 1988. 2 fig, 26 ref.

Descriptors: *Karst hydrology, *Groundwater, *Geohydrology, *Primary productivity, Drainage units, Heterotrophic environment, Ecosystem, Limestone, Surface-groundwater relations.

Karsts develop in limestone and, with their characteristic surface and underground forms, they constitute remarkable natural aquatic systems. They are considered open systems in which energy and matter can enter and leave, and they are closely dependent on the external phenomena that regulate their function. Karstic systems contain at least one drainage unit, and are made up of an impluvium, an underground reservoir (storage unit) and one or more outlets, which are linked to the regional geological structures and the respective positions of the geomorphological and karstic base levels. Since karstification is an erosion phenomenon directly linked to water, there is a fundamental relationship between water flow and karstification. The karst is a heterotrophic environment and the rate of primary production is lower than the respiration rate of the communities. The stability of the ecosystem is the result of an equilibrium between stabilizing forces (filtration of organic matter by the soil, accumulation of debris through filter feedings, nutrient recycling) and destabilizing forces (e.g. floods, pollution). Like superficial aquatic systems, karsts display complex hydrobiological and energetic dynamics. In the natural water cycle, karsts play an important role in surface water inputs. Transit of water through karstic systems results in a loss of energy and matter to the superficial hydrographic network. In a limestone region, these elements must be taken into consideration. (Davis-PTT)
W89-05195

EFFECT OF WALLS IN MODELING FLOW THROUGH POROUS MEDIA,
Michigan State Univ., East Lansing. Dept. of Mechanical Engineering.
C. W. Somerton, and P. Wood.
Journal of Hydraulic Engineering JHEND8, Vol. 114, No. 12, p 1431-1448, December 1988. 8 fig, 11 ref, append.

Descriptors: *Groundwater movement, *Boundary processes, *Flow characteristics, *Hydraulic models, *Porous media, *Viscous flow, Walls, Hydraulic engineering, Mathematical models, Viscosity, Porosity, Momentum transfer, Packed beds, Particle size, Hydraulic geometry, Hydraulic similitude, Fluid mechanics.

Many physical situations involving the flow of a fluid through porous media are on a very large scale. Examples include flow in an aquifer, flow through cooling-tower packing, flow in a packed-bed chemical reactor, and flow through a degraded nuclear-reactor core. In these cases, the scale is sufficiently large so that influences exerted by the boundaries may be ignored. Unfortunately, when an experiment is used to model these physical configurations, the scale of the experiment is typically not large. To be able to design an appropriate experiment requires knowledge on the effect of walls and development of similitude factors. A study has been undertaken to determine the effect of walls in the modeling of flow through porous media. Two primary influences of the wall are identified: packing effects for an unconsolidated porous medium, and viscous effects on the flow. The packing effect is considered through a series of experiments to arrive at an expression for the bulk porosity as a function of the ratio of particle diameter to pipe diameter. From this expression, and assuming that the region of greater haphazard packing occurs at a distance approximately one particle radius from the wall, a porosity of the wall region is determined. The viscous effects are accounted for by incorporating the Brinkman's extension term in the momentum equation. The combined effects are considered by employing a two region model for the fluid mechanics. (Author's abstract)
W89-05211

TYPE CURVES FOR TWO-REGIME WELL FLOW,
Technical Univ. of Istanbul (Turkey). Dept. of Civil Engineering.
Z. Sen.
Journal of Hydraulic Engineering JHEND8, Vol. 114, No. 12, p 1461-1484, December 1988. 14 fig, 6 tab, 30 ref.

Descriptors: *Mathematical models, *Fully penetrating wells, *Wells, *Flow characteristics, *Groundwater movement, Hydraulic models, Mathematical analysis, Well hydraulics, Darcys law, Flow pattern.

Nonequilibrium analytical solutions are presented for fully penetrating wells by incorporating the concept of the existence of a non-Darcy flow regime around the pumping well and a Darcian flow regime away from the well. For this purpose, an approximate procedure is proposed to find the distance to which the non-Darcy flow extends. This distance is referred to as the critical well radius, which divides the whole flow domain into nonlinear and linear flow zones with distinctive hydraulic characteristics. The nonlinear flow law is characterized by the Forchheimer equation. Detailed expressions are derived separately for the specific discharge calculations for each zone. Depending on the observation well locations, drawdown distributions and subsequently relevant type curves are developed mathematically for each zone. Various limiting cases are discussed and their physical implications in the practical applications are exposed. In general, linear regime zone type curves converge asymptotically, for large times as well as distances, to the Theis type curve, whereas such a convergence is valid for the nonlinear flow regime, but for small times only. (Author's abstract)
W89-05213

SATURATED SOIL HYDRAULIC CONDUCTIVITY IN LOBLOLLY PINE PLANTATIONS ON DRAINED SITES,
Raleigh, NC.
P. A. Nelson, and J. D. Gregory.
Water Resources Bulletin WARBAQ, Vol. 24, No. 4, p 743-748, August 1988. 1 fig, 4 tab, 20 ref.

Descriptors: *Groundwater movement, *Forest management, *Hydraulic conductivity, *Forest soils, *Forest hydrology, *Soil water, *Subsurface drainage, Pine trees, Saturated soils, Saturation, Saturation zone, Capillary water.

Variation of in situ measured saturated hydraulic conductivity (Ks) with stand age was examined in drained and intensively managed loblolly pine (Pinus taeda L.) plantations on very poorly drained Bayboro loam soils in the lower Coastal Plain of North Carolina. Stand ages studied were 1-year-old and 14-years old. No differences in Ks values were found between the stand ages. In addition, no differences in core measured soil properties were found between the stand ages indicating that there were no differences in the pore structure of the soil matrix. There was large variation of Ks within stands and between stands within ages. The mean within stand Ks values ranged from 0.66 cm/hr of 4.85 cm/hr. The frequency of tests exhibiting pipe flow through large non-capillary voids was significantly greater in the older stands; however, the continuity of the voids in the soil, and whether or not non-Darcy type flow would occur in saturated profile, could not be determined. (Author's abstract)
W89-05264

MUNICIPAL RESPONSES TO VOLATILE ORGANIC COMPOUNDS IN WISCONSIN GROUND WATER,
Wisconsin Univ.-Milwaukee. Center for Great Lakes Studies.
G. W. Page.
Water Resources Bulletin WARBAQ, Vol. 24, No. 4, p 847-854, August 1988. 3 fig, 3 tab, 30 ref.

Descriptors: *Water treatment, *Volatility, *Groundwater pollution, *Water quality control, *Wisconsin, *Municipal water, Public health, Water quality standards, Path of pollutants, Water policy.

Contamination of groundwater supplies with volatile organic compounds is a new and significant problem. Municipalities and their community water systems are often the first to discover groundwater contamination because of the monitoring programs they are required to carry out. When contamination exceeds standards, some action is required. The responses of Wisconsin municipalities to volatile organic compounds that exceed standards in their groundwater sources is described. Actions to protect human health are prompt, but the survey results indicate plumes of contaminated groundwater are usually not treated. They may continue to migrate and contaminate other private and public wells. (Author's abstract)
W89-05275

KLEBSIELLA SPP. IN PRAIRIE AQUIFER,
Regina Univ. (Saskatchewan). Dept. of Biology.
For primary bibliographic entry see Field 5B.
W89-05358

WATER SUPPLY TECHNICAL ASSISTANCE COLONIA FELIPE ANGELES, CIUDAD JUAREZ, CHIHUAHUA, MEXICO,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
H. Van, and W. M. Turner.
Water and Sanitation for Health Project Field Report No. 188, July 1986. AID Contract 5942-C-00-4085-00, Project 936-5942.

Descriptors: *Water supply development, *Wells, *Juarez, *Mexico, Colonia Felipe Angeles, Public participation, Rural areas, Water supply.

At the request of the USAID representative in Mexico City and authorized by USAID's Office of Health, the Water and Sanitation for Health (WASH) Project sent a two-person team to Ciudad Juarez, Chihuahua, in March 1986 to develop a groundwater exploration program and study alternative water supply schemes for Colonia Felipe Angeles, located northwest of downtown Juarez. The community presently has a population of approximately 40,000 inhabitants and is not served by the city of Juarez's water system. Recommendations from the study include: (1) a well field could be located in the vicinity of Colonia Anapra. The depth to water should be approximately 100 ft, and the wells will likely yield in excess of 200 U.S. gallons/minute; (2) At least two wells--each with adequate capacity to serve Colonia Felipe Angeles--should be constructed for water supply. This will allow for system redundancy in the event of the failure of a pump; (3) Communication between the community and the local water supply authorities should be improved through government representation in the Colonia Felipe Angeles 'Pro-Water Committee'; (4) The community should discuss with the Junta Municipal de Aguas and FIFAPA the way in which the community can assist in accomplishing the alternatives that are the most feasible; and (5) A latrine committee should be formed to begin working with local authorities in the design of a latrine program that would also meet the goals and plans of government agencies. (Lantz-PTT)
W89-05380

GROUND-WATER FLUCTUATIONS IN WISCONSIN,
Geological Survey, Madison, WI. Water Resources Div.
G. L. Patterson, and A. Zaporozec.
February 1986. 15p, 12 fig, 2 tab, 5 ref.

Descriptors: *Hydrologic data collections, *Groundwater budget, *Wisconsin, *Data acquisition, *Groundwater level, Wells, Statistical analysis, Precipitation, Earthquakes, Pumping.

In 1946, a statewide observation-well network was established in Wisconsin, by the U.S. Geological Survey in cooperation with the Wisconsin Geological and Natural History Survey. By the end of 1980, measurements were being made in 200 wells located in 68 of the 72 counties of the State. Of these wells, 23 were equipped with continuous recorders, 19 were measured weekly, and 158 were measured monthly. Water level records are available from the U.S. Geological Survey or Wisconsin Geological and Natural History Survey for about 225 wells across the state. This report summarizes statistical analyses of water-level measurements from 11 of these observation wells. The results of these analyses are discussed in terms of extremes in water levels, and how often high and low water levels might be expected to occur. The relation of water level fluctuations to precipitation and pumping also is discussed, as is the effect of earthquakes on water levels. Water levels in some artesian aquifers are very sensitive and react to the passage of shock waves even though such waves may not be detectable on the land surface. (Lantz-PTT)
W89-05389

HYDROGEOLOGY AND GROUND-WATER USE AND QUALITY, BROWN COUNTY, WISCONSIN,
Geological Survey, Madison, WI. Water Resources Div.
J. T. Krohelski.
Wisconsin Geological and Natural History Survey Information Circular No. 577, August 1986. 42p, 22 fig, 11 tab, 23 ref, append, 2 plates in pocket.

Descriptors: *Water use, *Geohydrology, *Groundwater quality, *Brown County, *Wisconsin, Permeability coefficient, Model studies, Groundwater budget, Aquifers.

The Paleozoic rock of Brown County includes formations of Cambrian, Ordovician, and Silurian age. The geologic and hydraulic characteristics of the aquifers and confining units are estimated from logs of more than 1,000 Brown County wells, from results of a packer test, and from published values. Recharge to the water table, which was estimated at five monitored sites, ranges from 1 to 6 inches a year; most recharge is contributed by spring snowmelt and rainfall. A cone of depression caused by pumping the deeper aquifers in the Green Bay metropolitan area induces flow from the upper aquifer to the underlying St. Peter aquifer throughout most of the county. Several reaches of Duck Creek and the Suamico River also contribute water to the aquifers. About 13 million gallons per day (GPD) of groundwater was pumped in Brown County during 1979, 63% of which was from wells open to both the St. Peter and Elk Mound aquifers. Municipal and industrial water users pumped 9.44 million gpd or 72% of the groundwater withdrawn in 1979. Most groundwater in the county is a calcium magnesium bicarbonate type. A three-dimensional digital model was used to simulate flow in the groundwater system. Model results indicate that sources of groundwater pumped from wells tapping the St. Peter and Elk Mound aquifers in Brown County, 1979, include 4.8 million gpd of underflow, most of which enters the county across the west border; 1.9 million gpd of flow from vertical leakage within the county; and 1.5 million gpd from storage. The model is most sensitive to the horizontal hydraulic conductivity of the upper aquifer. Vertical hydraulic conductivity of the confining units and recharge rates to the water table aquifer are the least well-defined model parameters. (Lantz-PTT)
W89-05391

WATER RESOURCES OF LANGLADE COUNTY, WISCONSIN,
Geological Survey, Madison, WI. Water Resources Div.
W. G. Batten.
Wisconsin Geological and Natural History Survey Information Circular 58, 1987. 28p, 13 fig, 7 tab, 17 ref, 1 plate in pocket.

Descriptors: *Water resources data, *Langlade County, *Wisconsin, *Groundwater budget, Wells, Transmissivity, Precipitation, Irrigation, Fish farming, Groundwater irrigation, Hydraulic conductivity, Groundwater chemistry.

Langlade County depends almost exclusively on groundwater pumped from the glacial sand and gravel deposits for its water needs. Well yields of 10 to 20 gallons per minute (gpm) can be obtained from these deposits throughout most of the county. Horizontal hydraulic conductivity values of glacial material range from < 1 ft/day in fine-grained glacial tills in western parts of the county to approximately 145 ft/day in outwash deposits. The transmissivity of glacial deposits ranges from essentially zero in areas of unsaturated glacial material to more than 40,000 sq ft/day in the outwash plain of south-central Langlade County. Most surface water and groundwater originates from precipitation falling within the county. Groundwater composition in Langlade County is similar to most groundwater in the State and is of suitable quality for most uses. It is a calcium magnesium bicarbonate type. Concentrations of total dissolved solids are relatively low and range from 71 to 369 mg/L, with a median value of 144 mg/L. An average of about 4.7 million gallons of water was pumped daily in Langlade County in 1983. Irrigation and fish rearing are the major groundwater uses in the county. An average of about 4.2 million gallons per day was pumped for irrigation during the months of June, July, and August. Results of this study show that present irrigation pumpage rates have little effect on groundwater levels in the Antigo Flats area. (Lantz-PTT)
W89-05392

DEVELOPING A STATE WATER PLAN: GROUND-WATER CONDITIONS IN UTAH, SPRING OF 1984,
Geological Survey, Salt Lake City, UT. Water Resources Div.
For primary bibliographic entry see Field 4B.
W89-05402

DEVELOPING A STATE WATER PLAN: GROUND-WATER CONDITIONS IN UTAH, SPRING OF 1983,
Geological Survey, Salt Lake City, UT. Water Resources Div.
For primary bibliographic entry see Field 4B.
W89-05403

WATER RESOURCES OF THE PARK CITY AREA, UTAH WITH EMPHASIS ON GROUND WATER,
Geological Survey, Austin, TX. Water Resources Div.
W. F. Holmes, K. R. Thompson, and M. Enright.
Utah Department of Natural Resources Technical Publication No. 85, 1986. 81p, 12 fig, 15 tab, 27 ref, 2 plates in pockets.

Descriptors: *Hydrologic studies, *Groundwater budget, *Park City, *Utah, Surface-groundwater relations, *Water resources data, Geohydrology, East Canyon Creek, Silver Creek, Streamflow, Groundwater recharge, Groundwater quality, Dissolved solids, Metals, Sulfates, Chloride, Wells.

The Park City area, about 140 sq mi in northern Utah, contains the headwaters of East Canyon, Silver, and Drain Tunnel Creeks, and a reach of the Provo River. The two major streams that originate within the study area are East Canyon and Silver Creek. The estimated long-term average flow of East Canyon Creek near Park City is 55 cu ft/sec, and the estimated long-term average flow of Silver Creek near Wanship is 8.55 cu ft/sec. Groundwater in the Park City area occurs in both unconsolidated valley fill and consolidated rocks. Recharge to the unconsolidated valley fill from precipitation, unconsumed irrigation water, leakage from consolidated rocks, and seepage from streams is estimated to be 15,400 acre-ft/yr. Recharge to the consolidated rocks from precipitation, stream infiltration and subsurface inflow is estimated to be 46,000 acre-ft/yr. Discharge from the unconsolidated valley fill by evapotranspiration, seepage to streams, and wells is estimated to be 15,500 acre-ft/yr. Discharge from consolidated rocks from springs, drain tunnels, leakage to unconsolidated valley fill, and wells is estimated to be 46,000 acre-ft/yr. Water in the unconsolidated valley fill generally follows the slope and direction of the major streams. Water in the consolidated rocks generally moves from recharge areas at high altitudes toward discharge areas at lower altitudes. The quality of both surface and groundwater in the Park City area generally is suitable for all uses, although some of the water had concentrations of dissolved solids, trace metals, chloride, or sulfate that exceeded recommended standards or limits. The Twin Creek Limestone and Thaynes Formation have the best potential for yielding large quantities of water to individual wells. (Lantz-PTT)
W89-05405

GROUND-WATER DATA FOR THE SALT BASIN, EAGLE FLAT, RED LIGHT DRAW, GREEN RIVER VALLEY, AND PRESIDIO BOLSON IN WESTERNMOST TEXAS,
Geological Survey, Austin, TX. Water Resources Div.
D. E. White, J. S. Gates, J. T. Smith, and B. J. Fry.
Texas Department of Water Resources Report 259, October 1980. 97p, 8 fig, 3 tab, 6 ref.

Descriptors: *Groundwater, *Texas, *Water resources data, Hydrologic data collections, Salt Basin, Eagle Flat, Red Light Draw, Green River, Presidio Bolson, Hydrologic data, River basins, Water use, Groundwater budget, Groundwater mining, Chemical analysis, Geophysics, Wells.

From October 1971 through October 1974, the U.S. Geological Survey collected groundwater data in the basins in Texas west of the Pecos River drainage area and northwest of the Big Bend country. The basins included are, from east to west: The Presidio Bolson; the Salt Basin; Green River Valley, Eagle Flat, and Red Light Draw. The data collection program consisted of an inventory of all major irrigation, municipal-supply, and industrial wells; selected stock and domestic wells; and selected springs. Water samples were collected from representative wells and springs for chemical analyses. (Lantz-PTT)
W89-05406

WATER RESOURCES OF THE APOSTLE ISLANDS NATIONAL LAKESHORE, NORTHERN WISCONSIN,
Geological Survey, Madison, WI. Water Resources Div.
For primary bibliographic entry see Field 2E.
W89-05408

GROUND WATER IN UTAH-A SUMMARY DESCRIPTION OF THE RESOURCE AND ITS RELATED PHYSICAL ENVIRONMENT,
Geological Survey, Salt Lake City, UT. Water Resources Div.
D. Price, and T. Arnow.
Utah Department of Natural Resources Water Circular 3, 1985. 49p, 21 fig, 3 tab, 16 ref.

Descriptors: *Groundwater, *Utah, Groundwater budget, *Water resources data, Groundwater mining, Groundwater quality, Water use.

Groundwater is one of Utah's most extensive and valuable natural resources. Because of its widespread occurrence in both wet and dry areas, groundwater has been, and is a major factor affecting economic growth and development of the State. In some areas, groundwater is used to supplement streamflow for irrigation, public supply, and other uses. In other areas, it is the only water available for use. The U.S. Geological Survey, under cooperative programs with the Utah Department of Natural Resources and other Federal, State, and local agencies has been studying Utah's groundwater resources since 1987. Much informa-

tion has been gained during those studies about the occurrence, availability, and quality of groundwater; the withdrawal and use of the water; and the effects of withdrawal. This report summarizes that information in nontechnical language, which is designed for all readers. (Lantz-PTT)
W89-05409

SEEPAGE STUDIES OF THE WEBER RIVER AND THE DAVIS-WEBER AND OGDEN VALLEY CANALS, DAVIS AND WEBER COUNTIES, UTAH, 1985,
Geological Survey, Salt Lake City, UT. Water Resources Div.
For primary bibliographic entry see Field 2E.
W89-05410

CHEMICAL QUALITY OF GROUND WATER IN SALT LAKE VALLEY, UTAH, 1969-85,
Geological Survey, Salt Lake City, UT. Water Resources Div.
For primary bibliographic entry see Field 5B.
W89-05411

GROUND-WATER CONDITIONS IN SALT LAKE VALLEY, UTAH, 1969-83, AND PREDICTED EFFECTS OF INCREASED WITHDRAWALS FROM WELLS,
Geological Survey, Salt Lake City, UT. Water Resources Div.
K. M. Waddell, R. L. Seiler, M. Santini, and D. K. Solomon.
Utah Department of Natural Resources Technical Publication No. 87, 1987. 69p, 26 fig, 5 tab, 15 ref.

Descriptors: *Salt Lake valley, *Groundwater level, *Groundwater budget, *Drawdown, Groundwater quality, Groundwater mining, Utah, Groundwater recharge, Municipal water, Computer models, Simulation analysis.

The average annual recharge and discharge from the groundwater reservoir in Salt Lake Valley, Utah, during 1969-82 were estimated to be about 352,000 and 353,000 acre-ft/yr. Withdrawals from wells increased from 107,000 acre-ft/yr during 1964-68 to 117,000 acre-ft/yr during 1969-82. The greatest increase in use was for public supply and institutions which increased from 35,000 acre-ft/yr during 1964-68 to 46,700 acre-ft/yr during 1969-82. From 1969 to 1983 water levels declined from 5 to 15 ft in the southeast part of the valley where pumpage from large public supply wells was greater during 1969-82 than during previous years. From February-March 1969 to February-March 1983 the quantity of groundwater in storage in Salt Lake Valley increased by about 33,000 acre-ft. A digital-computer model was calibrated to simulate, in three-dimensions, the groundwater flow in the principal and shallow-unconfined aquifers in Salt Lake Valley. Simulations were made to project the response to continuing withdrawals through 2020. Alternative pumping rates used were: (1) the 1982 rate of pumpage, and (2) increasing the 1982 rate of pumpage by 65,000 acre-ft. The simulation at the increased rate of pumpage indicated that drawdowns would reach 40-60 ft in the area east of Sandy. About 75% of the increased withdrawal was salvaged from water that otherwise would have been discharged to the Jordan River and its tributaries. (Author's abstract)
W89-05412

PROGRAM FOR MONITORING THE CHEMICAL QUALITY OF GROUND WATER IN UTAH--SUMMARY OF DATA COLLECTED THROUGH 1984,
Geological Survey, Salt Lake City, UT. Water Resources Div.
For primary bibliographic entry see Field 7A.
W89-05413

BEDROCK AQUIFERS OF EASTERN SAN JUAN COUNTY, UTAH,
Geological Survey, Salt Lake City, UT. Water Resources Div.
C. Avery.
Utah Department of Natural Resources Technical Publication No. 86, 1986. 114p, 29 fig, 11 tab, 1 plate, 49 ref.

Descriptors: *Bedrock, *Aquifers, *San Juan County, *Utah, *Groundwater budget, *Geohydrology, Aquifer systems, Groundwater recharge, Infiltration, Groundwater quality, Calcium bicarbonate, Sodium chloride, Hydraulic coefficient.

The water-bearing properties of the Navajo Sandstone and associated formations in southern Utah were appraised. The study area is about 4,600 sq mi, extending from the Utah-Arizona State line northward to the San Juan-Grand County line and westward from the Utah-Colorado State line. Some of the water yielding formations are grouped into aquifer systems. The C aquifer is comprised of the DeChelly Sandstone Member of the Cutler Formation. The P aquifer is comprised of the Cedar Mesa Member of the Cutler Formation and the undifferentiated Cutler Formation. The N aquifer is comprised of the sedimentary section that includes the Wingate Sandstone, Kayenta Formation, Navajo Sandstone, Carmel Formation, and Entrada Sandstone. The M aquifer is comprised of the Bluff Sandstone Member and other sandstone units of the Morrison Formation. The D aquifer is comprised of the Burro Canyon Formation and Dakota Sandstone. Discharge from the groundwater reservoir to the San Juan River between gaging stations at Four Corners and Mexican Hat is about 66 cu ft/sec. The N aquifer is the main aquifer in the study area. Recharge by infiltration of precipitation is estimated to be 25,000 acre-ft/yr. A major groundwater divide exists under the broad area east of Monticello. The thickness of the N aquifer, where the sedimentary section is fully preserved and saturated, generally is 750 to 1,250 ft. Hydraulic conductivity values obtained from aquifer tests ranged from 0.02 to 0.34 ft/day. The total volume of water in transient storage is about 11 million acre-ft. Well discharge somewhat exceeded 2,340 acre-ft during 1981. Discharge to the San Juan River from the N aquifer is estimated to be 6.9 cu ft/sec. Water quality ranges from a calcium bicarbonate to sodium chloride type water. (Author's abstract)
W89-05414

RECORDS OF WELLS, DRILLERS' LOGS, WATER-LEVEL MEASUREMENTS, AND CHEMICAL ANALYSES OF GROUND WATER IN BRAZORIA, FORT BEND, AND WALLER COUNTIES, TEXAS, 1980-84,
Geological Survey, Austin, TX. Water Resources Div.
J. F. Williams, C. E. Ranzau, W. B. Lind, and L. S. Coplin.
Texas Water Development Board Report 303, November 1987. 33p, 12 tab, 3 maps, 6 ref.

Descriptors: *Drillers logs, *Wells, *Groundwater level, *Groundwater quality, *Brazoria County, *Fort Bend County, *Waller County, *Hydrologic data collections, *Texas, Chemical analysis, Data collections.

Information on major new water wells in Brazoria, Fort Bend, and Waller Counties was compiled by the U.S. Geological Survey from 1980 through 1984. The results of the hydrologic data collection on new large capacity and other selected wells are presented, including well location and completion data, driller's logs of the strata penetrated, water levels, and chemical quality of the produced water. These water well data are supplementary to similar data on older wells in these counties and descriptive evaluations of the groundwater resources which have been published previously. (Author's abstract)
W89-05415

RECORDS OF WELLS, DRILLERS' LOGS, WATER-LEVEL MEASUREMENTS, AND CHEMICAL ANALYSES OF GROUND WATER IN CHAMBERS, LIBERTY, AND MONTGOMERY COUNTIES, TEXAS, 1980-84,
Geological Survey, Austin, TX. Water Resources Div.
J. F. Williams, L. S. Coplin, C. E. Ranzau, and W. B. Lind.
Texas Water Development Board Report 304, November 1987. 39p, 11 tab, 3 maps, 6 ref.

Descriptors: *Drillers logs, *Wells, *Groundwater level, *Groundwater quality, *Brazoria County, *Fort Bend County, *Waller County, *Hydrologic data collections, *Texas, Chemical analysis, Data collections.

Information on major new water wells in Chambers, Liberty, and Montgomery Counties was compiled by the U.S. Geological Survey from 1980 through 1984. The results of the hydrologic data collection on new large capacity and other selected wells are presented, including well location and completion data, driller's logs of the strata penetrated, water levels, and chemical quality of the produced water. These water well data are supplementary to similar data on older wells in these counties and descriptive evaluations of the groundwater resources which have been published previously. (Author's abstract)
W89-05416

SUMMARY OF HYDROLOGIC INFORMATION IN THE EL PASO, TEXAS, AREA, WITH EMPHASIS ON GROUND-WATER STUDIES, 1903-80,
Geological Survey, Austin, TX. Water Resources Div.
D. E. White.
Texas Water Development Board Report 300, August 1987. 75p, 36 fig, 8 tab, 77 ref.

Descriptors: *Hydrologic studies, *El Paso, *Groundwater budget, *Texas, *Hydrologic data collections, *Water resources data, Aquifers, Groundwater mining, Groundwater level, Dissolved solids, Groundwater irrigation, Groundwater recharge, Surface waters, Municipal water, Industrial water, Rio Grande River.

Significant development of groundwater in the El Paso area started in the early 1900's; pumping gradually increased to the early 1950's and has since accelerated commensurate with the area's rapid population growth. In 1980, withdrawals of groundwater for municipal, industrial, and military supplies totaled 164,354 acre-ft within the El Paso, Fort Bliss, and Ciudad Juarez, Mexico metropolitan area, and adjacent areas in Texas and New Mexico. Most of the water, 132,652 acre-ft was pumped from the Hueco bolson, the principal aquifer. The Mesilla bolson and Rio Grande alluvium in the lower Mesilla Valley supplied 27,461 and 4,241 acre-ft respectively. The cumulative 1906 through 1980 withdrawals of groundwater from the Hueco bolson metro area total 3.0 million acre-ft - about 2.2 million acre-ft has been pumped in the United States and 0.8 million acre-ft in the Republic of Mexico. These withdrawals have caused water levels to decline about 130 ft in the downtown sections of El Paso and Ciudad Juarez. In January 1980 the theoretically recoverable volume of freshwater in storage within the Texas part of the Hueco bolson metro area was estimated at 10.0 million acre-ft. Dissolved solids concentrations in recent samples from Hueco bolson wells average 642 mg/L in the Texas part of the metropolitan area and 736 mg/L in Ciudad Juarez. Concentrations are increasing at an average annual rate of about 10 mg/L in Texas and 30 mg/L in Juarez. Groundwater in the lower Mesilla Valley is pumped for municipal and industrial supply and also for supplemental crop irrigation during years of inadequate surface water supply in the Rio Grande. The 1979-80 withdrawals in the valley averaged about 31,000 acre-ft/yr. Most of the water, about 21,000 to 22,000 acre-ft/yr, was pumped from shallow, medium depth and deep wells in the Canutillo field. Dissolved solids concentrations from recent samples from Canutillo wells ranged from 252 to 1,854 mg/L. Flow in the Rio Grande is diverted for crop irrigation in the United States and the Republic of Mexico, and for limited municipal supply in El Paso. The flow is regulated by releases from reservoirs in New Mexico and varies widely in both quantity and quality (dissolved solids concentrations). During 1943-80, the flow at El Paso ranged from 57,481

acre-ft in 1956 to 631,800 acre-ft in 1943 and averaged about 317,000 acre-ft/yr. (Author's abstract)
W89-05417

DEVELOPMENT OF GROUND-WATER RESOURCES IN ORANGE COUNTY, TEXAS, AND ADJACENT AREAS, 1971-80,
Geological Survey, Austin, TX. Water Resources Div.
For primary bibliographic entry see Field 4B.
W89-05418

GROUND-WATER LEVELS AND PUMPAGE IN EAST-CENTRAL WASHINGTON, INCLUDING THE ODESSA-LIND AREA, 1967-1981,
Geological Survey, Olympia, WA.
D. R. Cline.
Water-Supply Bulletin No. 55, 1984. 34p, 21 fig, 4 ref.

Descriptors: *Pumpage, *Groundwater level, *Washington, *Groundwater mining, Pumping, Irrigation, Water use, Wells, Groundwater budget.

Groundwater pumpage, mostly for irrigation, has increased in the east-central Washington project area, from about 25,000 acre-ft of water in 1963 to about 387,000 acre-ft in 1977, causing continuing water level declines in parts of the area. Groundwater pumpage in the Odessa-Lind subarea increased from about 14,000 acre-ft to 163,000 acre-ft during the same period. The area of heavy pumping has expanded beyond the border of the Odessa-Lind area, especially to the south. The number of large-capacity wells in the project area has increased from 170 in 1963 to 618 in 1977. Few wells in 1967 were deeper than 1,000 ft, but by 1977 many were deeper. Most of the water pumped in 1967 was from wells tapping the Wanapum Basalt, but by 1977 most was from wells tapping both the Wanapum Basalt and the underlying Grande Ronde Basalt aquifers. Maximum water level declines in the Wanapum Basalt from spring 1968 to spring 1978 were over 80 ft, and from spring 1978 to spring 1981 were over 40 ft; maximum declines for the Wanapum and Grande Ronde Basalts were over 100 ft and 60 ft, respectively. Water levels were affected to a maximum distance of about 23 miles from pumping centers. Since 1967 the area affected by water level declines has expanded and shifted and the rate of decline has increased. The maximum decline of water levels from 1968 to 1981 has occurred in southern Adams County--about 130 ft in wells that tap the Wanapum Basalt and about 150 ft in wells that tap the Wanapum and Grande Ronde Basalts. (Author's abstract)
W89-05420

WATER IN THE HORSE HEAVEN HILLS, SOUTH-CENTRAL WASHINGTON,
Geological Survey, Tacoma, WA. Water Resources Div.
D. Molenaar.
Water-Supply Bulletin 51, 1982. 122p, 30 fig, 17 tab, 51 ref.

Descriptors: *Hydrology, *Water resources data, Washington, Horse Heaven Hills, Precipitation, Agriculture, Irrigation, Aquifers, Streamflow, Ephemeral streams, Suspended sediment, Wells, Drilling, Dry farming.

The study area of 1,460 sq mi has a temperate to semiarid climate, with mean annual precipitation ranging from about 25 inches in the higher western part to less than 10 inches in the lower eastern part. Until about 1970, the sparsely populated area had been characterized by dryland wheat farming and cattle and sheep grazing and production. In the 1970's, however, irrigation from the Columbia River resulted in a conversion to irrigated agriculture of about 64,000 acres (by 1977) of former dryland-farming and sagebrush land. Nearly concurrent development of irrigation from wells tapping large-yield artesian aquifers in the Columbia River Basalt Group has resulted in an additional 2,760 acres of agricultural land in the central part of the area. Sparse streamflow data show that, except for the lower spring-fed reach of Alder Creek, all streams are ephemeral. Discharges range from no flow to high flash-flood runoff, with a maximum daily discharge of 4,800 cu ft/sec in the lower reach of Rock Creek, recorded on December 22, 1965, during the 1963-68 period of record. The monthly suspended sediment discharge at this site in December 1965 was 280,000 tons. Data from 294 wells in the area, including drillers' logs (104 wells), geophysical analysis (25 wells), and water level observations (13 wells) disclose that wells range in depth from a few feet to 1,100 ft, well yields range from a few gallons per minute to artesian flows as great as 4,000 gallons per minute and specific capacities as great as 1,200 gallons per minute per foot. Water quality analyses of water from selected wells show hardness ranging from 17 to 218 mg/L and specific conductance ranging from 145 to 640 micromhos/cm. (Author's abstract)
W89-05421

RECHARGE STUDIES IN THE WESTERN MURRAY BASIN: 2. RESULTS OF A DRILLING PROGRAM AT WAMBI,
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
M. W. Hughes, I. D. Jolly, P. G. Cook, J. C. Dighton, and T. A. Beech.
Technical Memorandum 88/11, September 1988. 30p, 16 fig, 10 tab, 3 ref.

Descriptors: *Forest hydrology, *Dunes, *Forest watersheds, *Groundwater recharge, *Murray Basin, *Data collections, Australia, Drilling, Chlorides.

This report presents the results of a drilling program carried out in July 1985 near Wanbi, South Australia. The aim of the exercise was to determine if runoff from a mallee (Eucalyptus spp.) vegetated sand dune was causing enhanced recharge at the base of the dune. The study forms part of a larger project dealing with the effects of land clearing on groundwater recharge in the western Murray Basin. Samples collected were analyzed for chloride and water content. (Author's abstract)
W89-05423

GROUNDWATER FLOW AND QUALITY MODELLING.
D. Reidel Publishing Co., Boston. 1988. 843p. Edited by E. Custodio, A. Gurgui, and J. P. Lobo Ferreira.

Descriptors: *Water quality, *Groundwater movement, *Hydrologic models, *Path of pollutants, *Solute transport, Groundwater pollution, Aquifers, Mathematical models, Model studies, Data acquisition, Fracture permeability, Geohydrology, Mathematical equations, Mathematical studies.

Plenty of good papers on mass transport modeling are currently available to the scientific and technical community. However, it was felt that a meeting of leaders in the field from throughout the international community should be organized to discuss current developments, identify existing gaps, and try to define future trends and needs. This publication includes the papers discussed at the meeting. The order in which papers appear in the present publication has been altered somewhat. This is because some key papers were not available, while others fitted better under other headings. As a result, the present book is divided into seven parts: (1) Principles, basic equations and analytical solutions; (2) Modeling flow and transport in porous-like media; (3) Modeling flow and transport in fractured media; (4) Considerations of fluid-solid phase interactions and heterogeneity in modeling; (5) Multiphase flow and transport modeling; (6) Aquifer parameter identification by models; and (7) Data gathering and utilization of models. A final part is labeled 'Conclusions' and contains the four documents prepared by the four workshop groups. They refer to basic aspects, availability and characteristics of models, transport processes and application of models. (See W89-05466 thru W89-05505) (Lantz-PTT)
W89-05465

REVIEW OF STOCHASTIC THEORY OF TRANSPORT IN GROUNDWATER FLOW,
Tel-Aviv Univ. (Israel). Dept. of Fluid Mechanics and Heat Transfer.
G. Dagan.
IN: Groundwater Flow and Quality Modelling. D. Reidel Publishing Co., Boston. 1988. p 1-32, 4 fig, 35 ref.

Descriptors: *Stochastic hydrology, *Solute transport, *Groundwater movement, Heterogeneity, Stratified aquifers, Aquifers, Hydrologic studies, Mathematical equations, Mathematical analysis, Path of pollutants, Hydraulic conductivity.

A few field studies, which show that apparent dispersion is much larger than the pore-scale one and that it changes with distance from source, are first reviewed. These findings are attributed to large scale heterogeneity prevailing in natural formations. The spatial variability of hydraulic properties is regarded as random. The theory of transport by continuous, random, motions is presented and it is shown that it can model the field findings. The theory is subsequently applied to flow in stratified aquifers and in formations of two-dimensional or three-dimensional heterogeneous structures. The time-dependent effective dispersion coefficients are derived for average uniform flow. They are related to the formation hydraulic conductivity spatial distribution. These relationships are obtained by solving the equations of flow exactly (stratified formation) and by a perturbation approximation (general case). The theoretical results are compared with a recent field experiment of transport at the local scale. Finally, the uncertainty of concentration prediction for flow at regional scale is examined. The conditions under which concentration is ergodic and satisfied a convection-dispersion equation are discussed. (See also W89-05465) (Author's abstract)
W89-05466

IDENTIFICATION OF THE PARAMETERS OF GROUNDWATER MASS TRANSPORT,
Bureau de Recherches Geologiques et Minieres, Orleans (France).
For primary bibliographic entry see Field 5B.
W89-05467

BASIN-SCALE TRANSPORT OF DISSOLVED SPECIES IN GROUNDWATER,
Trento Univ. (Italy). Dept. of Engineering.
A. Rinaldo, and G. Gambolati.
IN: Groundwater Flow and Quality Modelling. D. Reidel Publishing Co., Boston. 1988. p 75-93, 3 fig, 32 ref.

Descriptors: *Groundwater basins, *Dissolved solids, *Geochemistry, *Water chemistry, *Solute transport, *Groundwater movement, Path of pollutants, Model studies, Hydrologic models, Aquifers, Mathematical studies, Mathematical analysis, Theoretical analysis, Statistical analysis.

The transfer function model (TFM) of field solute transport through unsaturated soils proposed in 1986, is generalized to basin-scale or aquifer-scale analysis through probabilistic arguments developed for basin contaminant responses to rainfall pulses. The class of models investigated is related to the law of mass conservation interpreted in the context of the probability theory. Under fairly general conditions the TFM may be regarded as a derived probability density function associated with the random holding time of a solute particle within the control volume and conditional on the time of occurrence of the solute injection. In the case of significant chemical, physical or biological transformation of the solute trace in the time scale of the travel time, the most probable distribution derived is the product of a generalized-gamma distribution by the solution of an integro-differential equation of macroscopic sorption. The potential impact of the approach for real-life field problems is related to the possibility of simulating solute response at a withdrawal station in arbitrarily large aquifers without actually solving complex differential transport equation. Whenever, in fact, the spatial and the time scale allow for the basic hypothe-

sis of average macroscopic sorption, only the ratio to the scales of convection-dispersion to that of sorption kinetics counts, and large-number formalisms seemingly apply. (See also W89-05465) (Lantz-PTT)
W89-05469

VARIABLE DENSITY FLUID FLOW IN THE BRACKISH TRANSITION ZONE BETWEEN FRESH AND SALINE GROUNDWATER,
Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands).
G. J. M. Uffink.
IN: Groundwater Flow and Quality Modelling. D. Reidel Publishing Co., Boston. 1988. p 95-110, 6 fig, 11 ref.

Descriptors: *Groundwater movement, *Brackish water, *Fluid flow, *Saline-freshwater interfaces, *Saline water intrusion, *Artificial recharge, Infiltration, Aquifers, Hydrologic models, Coastal aquifers, Mixing, Sand aquifers.

The fresh groundwater lying under the dunes along the coast forms an important source for the drinking water supply in the western part of the Netherlands. Artificial recharge with infiltration ponds is applied since 1955 to increase the freshwater reservoir. At this moment experiments are carried out with infiltration wells for artificial recharge in the deep aquifers, where both fresh and saline water occurs. Most techniques available for modeling of the flow of fresh and saline groundwater are based on the assumption that fresh and saline water do not mix. In reality mixing by dispersion occurs and a zone with brackish water is formed. Modeling of the brackish zone is important for management of the fresh water reservoir in the deep aquifers. In this study, the velocity distribution in the brackish zone under steady conditions is studied with a boundary layer analysis. The analysis also gives an expression for the total amount of salt flowing into the brackish zone. (See also W89-05465) (Author's abstract)
W89-05470

STATIONARY PRINCIPLES FOR FLOW AND TRANSPORT IN AQUIFERS,
Technion - Israel Inst. of Tech., Haifa.
S. Sorek.
IN: Groundwater Flow and Quality Modelling. D. Reidel Publishing Co., Boston. 1988. p 111-116, 3 ref.

Descriptors: *Solute transport, *Geochemistry, *Path of pollutants, *Groundwater movement, *Aquifers, Mathematical equations, Flow velocity.

Detailed numerical schemes are presented to solve flow and transport problems in aquifer domains. The schemes are based on variational concepts applied to integrals over rate of energy terms (the flow governing function) and rate of momentum terms (the transport governing function). The resulting set of equations describe solutions of the hydraulic head and solute concentration simultaneously over the entire time duration. For the transport problem, the equations link concentration field and velocity regime. This, in return, enables one to derive the velocity field from a given concentration field. (See also W89-05465) (Author's abstract)
W89-05471

OVERVIEW OF GROUNDWATER MODELLING,
Princeton Univ., NJ. Dept. of Civil Engineering.
G. F. Pinder.
IN: Groundwater Flow and Quality Modelling. D. Reidel Publishing Co., Boston. 1988. p 119-134, 2 fig, 83 ref.

Descriptors: *Literature review, *Model studies, *Groundwater movement, *Hydrologic models, Simulation analysis, Unsaturated flow, Path of pollutants, Mathematical models, Groundwater quality.

Numerical models have been used in groundwater hydrology for more than two decades. Early models focused on water supply and required the simulation of saturated media. Soil scientists introduced unsaturated flow concepts to modeling. Concern about groundwater quality led to the simulation of contaminant transport, beginning with problems of salt water intrusion. Modelling multiphase flow, particularly the flow of hydrocarbons, water and air is of current interest as is the simulation of fractured media flow and transport. The simulation of subsurface aqueous systems requires efficiently determined, accurate solutions to properly formulated governing equations. Approximation methods and algebraic equation solvers must be chosen carefully to balance accuracy, efficiency and dependability. No numerical procedure is 'best' for all problems and the experienced modeler must learn through experience the optimal approach to solving each class of mathematical-physical problems. (See also W89-05465) (Lantz-PTT)
W89-05472

INCORPORATING ASSURANCE INTO GROUNDWATER QUALITY MANAGEMENT MODELS,
Geological Survey, Menlo Park, CA.
For primary bibliographic entry see Field 5G.
W89-05473

EIGENVALUES APPROACH FOR SOLVING LINEAR GROUNDWATER FLOW PROBLEMS,
Universidad Politecnica de Valencia (Spain).
A. Sahuquillo, and J. Andreu.
IN: Groundwater Flow and Quality Modelling. D. Reidel Publishing Co., Boston. 1988. p 151-164, 4 fig, 17 ref. Spain-USA Joint Committee Grants 0355 and 83-09117.

Descriptors: *Groundwater movement, *Mathematical analysis, *Eigenvalues, Mathematical equations, Simulation analysis.

The eigenvalues method provides an explicit continuous-in-time solution for groundwater flow equations. Only space is discretized and a vector differential equation is obtained. Both finite differences and finite elements can be used to approximate partial derivatives of space. The eigenvalues and eigenvectors of a matrix, which is a function of the coefficients of the linear equations of the vector differential equation, are the key to the solution. The state of the aquifer can be expressed on the orthonormal basis provided by the eigenvectors. Hydraulic head or flow at specific points can be explicitly obtained for particular times of interest. Also, in most real cases, external actions can be expressed as a linear combination of a reduced set of stresses, allowing there to be an important reduction in computation. Other important reduction in computation can be achieved owing to the rapid approximation to the steady state solution of many of the orthogonal components. The approach is most useful when the simulation to be made for various alternatives is of considerable accumulative length. (See also W89-05465) (Author's abstract)
W89-05474

NEW METHOD FOR DIFFUSIVE TRANSPORT,
Universidad Nacional Autonoma de Mexico, Mexico City. Inst. de Geofisica.
I. Herrera.
IN: Groundwater Flow and Quality Modelling. D. Reidel Publishing Co., Boston. 1988. p 165-172, 4 fig, 7 ref.

Descriptors: *Numerical analysis, *Solute transport, *Diffusive transport, *Groundwater movement, *Diffusivity, Mathematical equation, Diffusion, Advection, Mathematical studies.

A new numerical solution procedure is presented for the one-dimensional, transient advective-diffusive transport equation. The methodology is an extension of Herrera's algebraic theory of numerical methods. This approach has been developed for general linear operators. Within the algebraic theory, careful choice of the weighting functions in a weak form statement of the problem leads to a numerical approximation that inherently accommodates different degrees of advection domination. Special treatment of the time dependence leads to algorithms that produce superior results for a very wide range of grid Peclet numbers, as has been demonstrated in several test problems. (See also W89-05465) (Author's abstract)
W89-05475

COMPARISON OF FAST EQUATION SOLVERS FOR GROUNDWATER FLOW PROBLEMS,
Ruhr Univ., Bochum (Germany, F.R.).
G. Schmid, and D. Braess.
IN: Groundwater Flow and Quality Modelling. D. Reidel Publishing Co., Boston. 1988. p 173-188, 10 fig, 3 tab, 8 ref.

Descriptors: *Digital computers, *Computer programs, *Mathematical equations, *Groundwater movement, *Model studies, Simulation analysis, Computers.

Groundwater modeling has become an important tool in water management and often simulation models are developed with several thousand nodes. In order to save computer time equation solvers with high efficiency have to be chosen, especially when dealing with time-dependent and non-linear problems. Besides the direct Cholesky or frontal solvers, conjugate gradient techniques have become attractive in the last decade mainly due to improved preconditioned methods. Another type of iterative procedure, the multi-grid methods led to a high reduction in computer time. In this paper, the PCG-method is compared with direct equation solvers applied in an areal model. The 2-dimensional dam problem is investigated on a uniform mesh where, in addition, a multi-grid method is applied. Results show the superiority of the PCG- and multi-grid methods. (See also W89-05465) (Author's abstract)
W89-05476

MODELLING FLOW AND TRANSPORT THROUGH POROUS MEDIA ON VECTOR COMPUTERS,
Technische Hochschule Aachen (Germany, F.R.). Lehrstuhl fuer Wasserbau und Wasserwirtschaft und Inst. fuer Wasserbau.
For primary bibliographic entry see Field 7C.
W89-05477

EULERIAN-LAGRANGIAN METHOD FOR SOLVING TRANSPORT IN AQUIFERS,
Technion - Israel Inst. of Tech., Haifa.
For primary bibliographic entry see Field 7C.
W89-05478

HYDRODYNAMIC DISPERSION IN MODEL POROUS MEDIA,
Thessaloniki Univ., Salonika (Greece). School of Technology.
For primary bibliographic entry see Field 7C.
W89-05479

RANDOM WALK METHOD IN POLLUTANT TRANSPORT SIMULATION,
Stuttgart Univ. (Germany, F.R.). Inst. fuer Wasserbau.
For primary bibliographic entry see Field 5B.
W89-05480

MODELING OF SOLUTE TRANSPORT WITH THE RANDOM WALK METHOD,
Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands).
For primary bibliographic entry see Field 5B.
W89-05481

MODELLING OF FLOW THROUGH FRACTURED ROCKS: GEOSTATISTICAL GENERATION OF FRACTURE NETWORKS. STRESS-FLOW RELATIONSHIP IN FRACTURES,
Bureau de Recherches Geologiques et Minieres,

Orleans (France).
B. Feuga.
IN: Groundwater Flow and Quality Modelling. D. Reidel Publishing Co., Boston. 1988. p 269-297, 22 fig, 10 ref.

Descriptors: *Stress, *Geologic fractures, *Model studies, *Statistical models, *Geohydrology, *Model studies, *Fracture permeability, *Groundwater movement, Statistical analysis, Geomorphology, Mathematical analysis, Poisson ratio, Channeling.

A geostatistical approach to fracturing is presented. Application to a granite intrusion shows that its fracturing is organized at two levels as nested structures. A particular random process, the 'regionalized density Poissonian process' makes it possible to generate fracture fields statistically and geostatistically similar to the real fracture field. A detailed study of the morphology of a fracture in granite, and laboratory testing of this fracture under normal stress leads to a so-called 'confined teeth model' which enables a good modeling of the stress/closure behavior of the fracture. Tentative application of a similar concept to the stress/flow behavior of the fracture, based upon the commonly accepted laws of flow in fractures, shows that these laws no longer apply for narrow fractures, due to a channeling phenomenon. An insight is given into how this phenomenon could be modeled. (See also W89-05465) (Author's abstract)
W89-05482

COMBINED SEISMIC AND HYDRAULIC METHOD OF MODELING FLOW IN FRACTURED LOW PERMEABILITY ROCKS,
California Univ., Berkeley. Dept. of Mathematics.
P. A. Witherspoon, J. C. S. Long, E. L. Majer, and L. R. Myer.
IN: Groundwater Flow and Quality Modelling. D. Reidel Publishing Co., Boston. 1988. p 299-329, 16 fig, 4 tab, 40 ref. DOE Contract DE-AC03-76SF00098.

Descriptors: *Geologic fractures, *Model studies, *Aquifer testing, *Seismology, *Geohydrology, *Groundwater movement, *Hydraulic studies, *Fracture permeability, Permeability, Mathematical models, Mathematical studies, Seismology, Geothermal studies.

Modeling flow of groundwater in hard rocks where a network of fractures provides the dominant flow paths is a major problem. This paper summarizes a program of investigations currently underway to characterize the geometry of fractured rocks and develop methods of handling flow in such systems. Numerical models have been developed to investigate flow behavior in two- and three-dimensional fracture networks. The results demonstrate the insights that can be gained from modeling studies of fractured rocks. A key problem is gathering the necessary data on fracture geometry. Investigations have been started to determine how vertical seismic profiling (VSP) might be improved and applied to this problem. A VSP experiment in The Geysers geothermal field in northern California, where fracture orientation is known, produced shear wave splitting and velocity anisotropy in agreement with theory. The results suggest the potential application of 3-component, multi-source VSP data in determining fracture orientation and average spacing. The authors believe a combination of seismic and hydraulic methods can greatly enhance an understanding of fluid flow and transport in low permeability rock systems where fractures provide the dominant paths. (See also W89-05465) (Author's abstract)
W89-05483

STOCHASTIC CONTINUUM REPRESENTATION OF FRACTURED ROCK PERMEABILITY AS AN ALTERNATIVE TO THE REV AND FRACTURE NETWORK CONCEPTS,
Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.
S. P. Neuman.
IN: Groundwater Flow and Quality Modelling. D. Reidel Publishing Co., Boston. 1988. p 331-362, 1 fig, 3 tab, 82 ref.

Descriptors: *Geologic fractures, *Stochastic process, *Fracture permeability, *Geohydrology, *Groundwater movement, Porous media, Model studies, Hydraulic conductivity.

Laboratory and field measurements of hydraulic conductivity (or permeability) in porous media represent averages over many years. Laboratory and field measurements of hydraulic conductivity in fractured rocks represent volumes that are often intersected by only a few fractures. Therefore, these measurements tend to be erratic and sensitive to the volume of rock sampled by the test. For this erratic behavior and sensitivity to be acceptably small, the test would have to be conducted on a relatively large scale at which the sample corresponds to a Representative Elementary Volume or REV. However, there is generally no guarantee that an REV can be defined for a given rock mass. When an REV can be defined, it is often so large as to render the measurement of its hydraulic conductivity impractical. To study questions related to the existence and properties of REV's and/or to eliminate the need for their use, some investigators have relied on discrete models of fracture networks. These models require detailed deterministic and/or statistical information about the geometry of fractures and the spatial distribution of their apertures which is difficult to obtain. In addition, there is growing laboratory and field evidence that the manner in which such models translate data about fracture geometry into hydraulic and transport properties of the rock is open to serious questions. This paper describes an alternative to both the classical continuum concept based on an REV and the discrete fracture network approach. The proposed alternative places less emphasis on fracture geometric data than on the results of hydraulic tests conducted on scales at which testing is practical with available technology. The studies demonstrate that such hydraulic test data are amenable to quantitative analysis by treating them as the realization of a stochastic process defined over a continuum. The nature of this stochastic process on scales smaller and/or larger than the scale of measurement can be studied by means of deconvolution and/or spatial average techniques. In this way, data obtained on different scales can be analyzed jointly within a unified conceptual framework so as to reinforce each other. (See also W89-05465) (Author's abstract)
W89-05484

FLOW IN THREE-DIMENSIONAL FRACTURE NETWORKS USING A DISCRETE APPROACH,
Cornell Univ., Ithaca, NY. Dept. of Environmental Engineering.
J. A. Liggett, and D. Medina.
IN: Groundwater Flow and Quality Modelling. D. Reidel Publishing Co., Boston. 1988. p 363-374, 8 fig, 1 tab, 8 ref.

Descriptors: *Model studies, *Fracture permeability, *Groundwater movement, *Mathematical analysis, Mathematical models, Geohydrology, Mathematical equations, Computer programs.

The flow in a three-dimensional network of discrete fractures is calculated by the boundary element method. The flow in any one fracture is two-dimensional but these fractures may be connected in a three-dimensional network. Alternatively, the same method of calculation (and the same computer program) can compute two-dimensional flow in fractures and the intervening media. The boundary element method is extraordinarily effective in computing flow in three-dimensional networks of fractures. The requirement for data is much less than for the comparable finite element analysis and the program shows great efficiency. A mathematical difficulty with any numerical method is the treatment of the intersections of zones at corners. The proper path equations can be written but are difficult to implement. Approximate methods include the use of generic closure equations or non-conforming elements. The use of the generic equations has little effect on the overall solution although the solution is noticeably different in the immediate vicinity of the corners. (See also W89-05465) (Author's abstract)
W89-05485

MINC: AN APPROACH FOR ANALYZING TRANSPORT IN STRONGLY HETEROGENEOUS SYSTEMS,
California Univ., Berkeley. Lawrence Berkeley Lab.
T. N. Narasimhan, and K. Preuss.
IN: Groundwater Flow and Quality Modelling. D. Reidel Publishing Co., Boston. 1988. p 375-391, 4 fig, 21 ref.

Descriptors: *Multiple Interacting Continua, *Groundwater movement, *Solute transport, *Heterogeneity, *Finite element method, Diffusivity, Mathematical equations, Model studies, Hydraulic models, Estimating.

Systems in which materials of low-diffusivity occur as islands in pervasive high-diffusivity materials are considered in this study. In these systems, global three-dimensional transport occurs in the high-diffusivity materials. Transport in the low-diffusivity materials is local and one-dimensional in nature. MINC (Multiple Interacting Continua) is a method for efficiently simulating transport in such systems. The Integral Finite Difference Method (IFDM) provides a convenient way for implementing MINC. Known information on the shape and the size of the blocks can be judiciously utilized to obtain improved accuracy in estimating transport into the islands. MINC permits handling of continua at several hierarchical levels. (See also W89-05465) (Author's abstract)
W89-05486

STOCHASTIC PARTICLE TRANSPORT MODEL BASED ON DIRECTIONAL STATISTICS OF FLOW THROUGH FRACTURE NETWORKS,
Quebec Univ., Chicoutimi.
A. Rouleau.
IN: Groundwater Flow and Quality Modelling. D. Reidel Publishing Co., Boston. 1988. p 393-406, 7 fig, 30 ref.

Descriptors: *Stochastic models, *Geologic fractures, *Model studies, *Groundwater movement, *Fracture permeability, *Particulate matter, Solute transport, Monte Carlo method, Stochastic process, Computers.

The geometry of the fracture system is the main factor controlling the transport of non-reacting solutes and particles through fractured rocks of low matrix permeability. A number of transport models through discrete fracture networks have already been developed. Unfortunately, the memory size in currently available computers limits greatly the applicability of these transport models on site specific problems. The transport model NETRANS presented here uses a Monte Carlo approach to follow particles through a virtual fracture network. This stochastic model is based on the statistics of three directional parameters: flow rate, flow velocity, and length of fracture segments. These parameters are previously computed by other programs simulating steady-state flow in stochastically generated fracture networks. NETRANS follows a number of particles, one at a time, through a virtual fracture network. At each step, or virtual node, the flow direction is determined stochastically by the relative importance of the flow rate in each ten-degree range of direction. The displacement distance and velocity are then determined by the statistics of segment lengths and flow velocities in that direction. This particle transport model can simulate the migration of particles over a distance much larger than the initial fracture domain used for the flow simulation. The model is applied to a gneissic rock mass from which detailed data are available on the hydrology and the fracture systems. (See also W89-05465) (Author's abstract)
W89-05487

ADVANCES IN MODELLING WATER-ROCK INTERACTION IN AQUIFERS,
Kiel Univ. (Germany, F.R.). Geologisch-Palaeontologisches Inst. und Museum.
G. Matthess.
IN: Groundwater Flow and Quality Modelling. D.

Reidel Publishing Co., Boston. 1988. p 409-422, 2 fig, 27 ref.

Descriptors: *Model studies, *Model studies, *Geohydrology, *Path of pollutants, *Groundwater movement, *Geochemistry, Mathematical models, Kinetics, Chemical reactions, Solute transport, Advection, Groundwater quality, Aquifers.

The development of groundwater quality and the transport behavior of contaminants in the subsurface are controlled by hydraulic processes mainly through chemical and physicochemical reactions between water and rock. Geochemical models using a equilibrium or a kinetic concept are useful tools for a better understanding of the rock-water interaction and of the development of water quality along the subsurface flow path. Both concepts may be used for combined advection-dispersion-reaction models, which of course are a challenge for both hydraulic and geochemical modelers. There is no question that any advance of modeling groundwater quality development and the behavior of non-conservative contaminants needs interdisciplinary cooperation. (See also W89-05465) (Author's abstract)
W89-05488

PARAMETERS FOR MODELLING THE TRANSPORT OF CADMIUM AS INFLUENCED BY THE CHEMICAL PROPERTIES OF GROUND WATER AND AQUIFER MATERIAL,
Kiel Univ. (Germany, F.R.). Geologisch-Palaeontologisches Inst. und Museum.
For primary bibliographic entry see Field 5B.
W89-05489

MICRO-SCALE MODELLING IN THE STUDY OF PLUME EVOLUTION IN HETEROGENEOUS MEDIA,
Waterloo Univ. (Ontario). Inst. for Ground Water Research.
For primary bibliographic entry see Field 5B.
W89-05490

MODELLING THE INCREASING DISPERSIVITY WITH FE TRANSPORT MODELS USING THE MULTILAYER CONCEPT,
Karlsruhe Univ. (Germany, F.R.). Inst. fuer Hydromechanik.
For primary bibliographic entry see Field 5B.
W89-05491

RANDOM-WALK METHOD TO SIMULATE POLLUTANT TRANSPORT IN ALLUVIAL AQUIFERS OR FRACTURED ROCKS,
Strasbourg-1 Univ. (France). Inst. de Mechanique des Fluides.
For primary bibliographic entry see Field 5B.
W89-05492

FLUID-MECHANICAL ASPECTS OF THE MIGRATION OF CHEMICALS IN FRACTURED MEDIA,
For primary bibliographic entry see Field 5B.
W89-05494

STATE OF THE ART OF THE INVERSE PROBLEM APPLIED TO THE FLOW AND SOLUTE TRANSPORT EQUATIONS,
Universidad Politecnica de Cataluna, Barcelona (Spain). Escuela Tecnica Superior de Ingenieros de Caminos, Canales y Puertos.
J. Carrera.
IN: Groundwater Flow and Quality Modelling. D. Reidel Publishing Co., Boston. 1988. p 549-583, 5 fig, 108 ref. U.S.-Spain Joint Committee for Scientific and Technologic Cooperation Research Grant CCA851005.

Descriptors: *Mathematical studies, Literature review, *Groundwater movement, *Solute transport, *Model studies, Statistical methods, Mathematical equations, Network design, Experimental design.

Various approaches to the inverse problem of both flow and solute transport equations are reviewed. Despite being an area of very active research the solute transport inverse problem seems to be far from the stage of becoming widely applicable. Flow parameters can be estimated under a wide range of conditions by several methods. The most recent ones can be classified under two general categories: stochastic and minimization methods. The former appears to be very promising, but currently can only be applied under very restrictive conditions. Minimization methods are much more applicable. Research efforts on minimization seem to converge on the need of an adequate statistical framework for posing the objective function to be minimized, and of including prior information on model parameters to improve the stability properties of the solution. This also improves the reliability of the estimates. Current research efforts along this line concentrate on: (1) Various computational improvements; (2) Accurate evaluation of parameter uncertainty; (3) Network and experiment design to ensure that measured data provide as much information as possible with regard to the parameters; and (4) Methodologies for identification of the model structure. (See also W89-05465) (Lantz-PTT)
W89-05496

ESTIMATION OF SPATIAL COVARIANCE STRUCTURES WITH APPLICATION TO HYDROLOGICAL, HYDROCHEMICAL AND ISOTOPIC DATA FROM AQUIFERS: STATE-OF-THE-ART AND ADJOINT STATE MAXIMUM LIKELIHOOD CROSS-VALIDATION METHODS,
Universidad Politecnica de Madrid (Spain). Escuela Tecnica Superior de Ingenieros de Caminos.
F. J. Samper, and S. P. Neuman.
IN: Groundwater Flow and Quality Modelling. D. Reidel Publishing Co., Boston. 1988. p 585-620, 3 fig, 3 tab, 66 ref, append.

Descriptors: *Statistical studies, *Isotope studies, *Groundwater movement, *Stochastic models, *Model studies, Mathematical models, Solute transport, Geohydrology, Hydrologic data, Aquifers, Estimating, Literature review.

Stochastic models of groundwater flow and solute transport require knowing the spatial statistics of geohydrological variables. A review of proposed methods for estimating these statistics has shown that almost all the existing methods have some drawbacks and limitations and are based on simplifying assumptions. Adjoint State Maximum Likelihood Cross-Validation (ASMLCV) methods stand out for being able to deal with geohydrological data. These data often contain sampling and measurement errors, represent vertically-averaged values and can show spatial drifts. Advantages of ASMLCV methods include: (1) the use of identification criteria for selecting a covariance mode, (2) the computation of parameter estimation errors, (3) the use of a highly efficient numerical algorithm based on adjoint state theory, and (4) the ability to analyze issues such as parameter identifiability and uniqueness and stability of the solutions. The capabilities of these methods have been illustrated with applications to synthetic and field hydrological, hydrochemical and isotopic data. (See also W89-05465) (Lantz-PTT)
W89-05497

BAYESIAN IDENTIFICATION OF STEADY-STATE (ANISOTROPIC) GROUNDWATER FLOW MODELS,
Louvain Univ. (Belgium). Lab. d'Automatique, Dynamique et Analyse des Systemes.
G. Bastin.
IN: Groundwater Flow and Quality Modelling. D. Reidel Publishing Co., Boston. 1988. p 621-640, 1 fig, 18 ref, 2 append.

Descriptors: *Anisotropy, *Groundwater movement, *Steady flow, *Mathematical models, Transmissivity, Hydraulic properties, Random Walk method.

Two Bayesian identification methods for steady state groundwater flow systems are presented. The first is based on the assumption that the transmissivity is a random walk field, while the second is based on a transmissivity covariance model explicitly computed from the piezometric field covariance. With this approach, the numerical value of the transmissivity data and their geometric positions (with respect to the grid nodes) are treated in a straightforward and logical way, and although the optimality criterion is derived using probabilities, it appears as a powerful mathematical tool to give strictness and coherence to the identification procedure. (See also W89-05465) (Lantz-PTT)
W89-05498

PRESENT LIMITATIONS AND PERSPECTIVES ON MODELING POLLUTION PROBLEMS IN AQUIFERS,
Geological Survey, Reston, VA.
For primary bibliographic entry see Field 5B.
W89-05499

ADVANCES IN THE ASSESSMENT OF DATA WORTH FOR ENGINEERING DECISION ANALYSIS IN GROUNDWATER CONTAMINATION PROBLEMS,
British Columbia Univ., Vancouver. Dept. of Geological Sciences.
For primary bibliographic entry see Field 5B.
W89-05500

COMPARATIVE ANALYSIS OF MATHEMATICAL MASS TRANSPORT CODES FOR GROUNDWATER POLLUTION STUDIES,
Laboratorio Nacional de Engenharia Civil, Lisbon (Portugal).
For primary bibliographic entry see Field 5B.
W89-05501

NEW APPROACHES AND APPLICATIONS IN SUBSURFACE FLOW MODELING: 3-D FINITE ELEMENT ANALYSIS OF DEWATERING FOR AN ELECTRO-NUCLEAR PLANT,
Padua Univ. (Italy). Inst. of Applied Mathematics.
For primary bibliographic entry see Field 8A.
W89-05502

LARGE SCALE 3-D GROUNDWATER FLOW MODELLING IN HIGHLY HETEROGENEOUS GEOLOGIC MEDIUM,
Neuchatel Univ. (Switzerland). Center of Hydrology.
L. Kiraly.
IN: Groundwater Flow and Quality Modelling. D. Reidel Publishing Co., Boston. 1988. p 761-775, 12 fig, 6 ref.

Descriptors: *Groundwater movement, *Geohydrology, *Heterogeneity, *Model studies, Simulation analysis, Aquifers, Finite element method, Switzerland, Regional analysis, Fracture permeability.

Regional modeling of groundwater flow in a highly heterogeneous geologic medium often requires the simulation of one-dimensional or two-dimensional discontinuities (regional faults, karstic networks, thin aquifers) embedded in an otherwise 'continuous' medium. However, finite element models allowing for the association of 1-D, 2-D and 3-D elements are not yet widely used, very probably because of the problems related to the calculation of 2-D element matrixes in a 3-D global space. A simple method, making use of the metric tensor, is proposed to overcome these difficulties, and the assembly of 1-D, 2-D and 3-D elements is illustrated by a theoretical example, as well as by the regional groundwater flow model of Northern Switzerland. Combining the continuum approach with the 'discrete fracture' model seems to be a reasonable way to model a highly heterogeneous geologic medium at a regional scale. As the presence of 1-D or 2-D elements in the model does not increase the number of nodes which would be necessary for the 3-D elements alone, the discontinuities can be put in, or taken out of the model without difficulty. Associating 1-D, 2-D and 3-D elements has, however, a serious drawback, which

causes difficulties for users of some very fine flow-path calculation routines: the 1-D and 2-D elements 'trap' the flow lines. A flow line which is well identified in a 3-D element will 'lose its identity' when it enters into a 2-D zone, and the point where it leaves the 2-D element is completely undetermined. (See also W89-05465) (Lantz-PTT)
W89-05503

GATHERING OF DATA FOR MODELLING,
Danmarks Geologiske Undersoegelse, Copenhagen.
For primary bibliographic entry see Field 7A.
W89-05504

PRESENT STATE OF COASTAL AQUIFER MODELLING: SHORT REVIEW,
Universidad Politecnica de Cataluna, Barcelona (Spain). Escuela Tecnica Superior de Ingenieros de Caminos, Canales y Puertos.
E. Custodio.
IN: Groundwater Flow and Quality Modelling. D. Reidel Publishing Co., Boston. 1988. p 785-801, 65 ref. U.S.-Spain Joint Committee for Scientific and Technical Research Projects CCA8309/007 and CCA8510/0011.

Descriptors: *Literature review, *Coastal aquifers, *Model studies, Fluid dynamics, Mixing, Saline-freshwater interfaces, Permeability, Chemical reactions, Groundwater.

In most situations, coastal aquifer modeling has to contend with the existence of a variable density fluid or two fluids of different densities separated by an interface. Depending on the kind of situation that exists, different approaches are used. Solutions with a sharp interface are easier to model but there are limitations on their physical validity. Some aspects are still an open field for research, especially when mixing of salt and freshwater has to be considered. Mixing may alter environmental permeability, by dissolution, precipitation or changes in the behavior of clay particles. This is a poorly known phenomenon from the point of view of representative modeling of existing aquifers. (See also W89-05465) (Author's abstract)
W89-05505

RUHENGERI WATER RESOURCES STUDY RWANDA,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
For primary bibliographic entry see Field 2E.
W89-05527

AQUEOUS GEOCHEMISTRY OF THE BRADYS HOT SPRINGS GEOTHERMAL AREA, CHURCHILL COUNTY, NEVADA,
For primary bibliographic entry see Field 2K.
W89-05588

ESTIMATING STREAM-AQUIFER INTERACTIONS IN COAL AREAS OF EASTERN KANSAS BY USING STREAMFLOW RECORDS,
For primary bibliographic entry see Field 2E.
W89-05590

INVESTIGATIONS OF ORGANIC CONTAMINANTS DERIVED FROM WOOD-TREATMENT PROCESSES IN A SAND AND GRAVEL AQUIFER NEAR PENSACOLA, FLORIDA,
For primary bibliographic entry see Field 5B.
W89-05591

EVALUATING STRATEGIES FOR GROUNDWATER CONTAMINANT PLUME STABILIZATION AND REMOVAL,
For primary bibliographic entry see Field 5G.
W89-05592

PLANNING FOR GROUNDWATER PROTECTION.
For primary bibliographic entry see Field 5G.
W89-05600

HYDROGEOLOGIC FRAMEWORK FOR GROUNDWATER PROTECTION,
Wisconsin Univ.-Madison. Dept. of Geology and Geophysics.
For primary bibliographic entry see Field 5B.
W89-05601

INSTITUTIONAL FRAMEWORK FOR PROTECTING GROUNDWATER IN THE UNITED STATES,
Environmental Protection Agency, New York. Region II.
For primary bibliographic entry see Field 5G.
W89-05602

LONG ISLAND CASE STUDY,
Long Island Regional Planning Board, Hauppauge, NY.
For primary bibliographic entry see Field 5G.
W89-05606

DADE COUNTY, FLORIDA, CASE STUDY,
Dade County Planning Dept., Miami, FL.
For primary bibliographic entry see Field 5G.
W89-05607

WAUSAU, WISCONSIN, CASE STUDY,
Wisconsin Univ.-Milwaukee. Dept. of Urban Planning.
For primary bibliographic entry see Field 5G.
W89-05608

PERTH AMBOY, NEW JERSEY, CASE STUDIES,
Wisconsin Univ.-Milwaukee. Dept. of Urban Planning.
For primary bibliographic entry see Field 5G.
W89-05610

SOUTH BRUNSWICK, NEW JERSEY, CASE STUDY,
Wisconsin Univ.-Milwaukee. Dept. of Urban Planning.
For primary bibliographic entry see Field 5G.
W89-05612

MODELING GROUNDWATER FLOW AND POLLUTION: WITH COMPUTER PROGRAMS FOR SAMPLE CASES,
Technion - Israel Inst. of Tech., Haifa. Faculty of Civil Engineering.
J. Bear, and A. Verruijt.
D. Reidel Publishing Company, Boston, Massachusetts. 1987. 414p.

Descriptors: *Model studies, *Groundwater movement, *Groundwater pollution, *Path of pollutants, *Mathematical models, Solute transport, Mathematical studies, Aquifers, Model studies, Computer programs, Flow profiles.

This textbook is devoted to the building and use of mathematical and numerical models for the analysis of groundwater flow and the transport of pollution by moving groundwater. It deals with the general principles involved and pays special attention to both the understanding of the physical mechanisms that govern the movement and accumulation of groundwater and pollutants in aquifers and to the construction of conceptual, mathematical and numerical models. A large part of the book is concerned with actual numerical models, mainly based on the finite difference and finite element methods. A large number of complete computer programs, in BASIC, are included. The programs can be run on personal computers and are both educational and 'semi-professional'. Programs are presented for both steady and unsteady two-dimensional flow in nonhomogeneous aquifers, for flow through dams, for the transport of pollutants by advection and by dispersion, and for saltwater intrusion problems. (Lantz-PTT)
W89-05754

COMPUTATIONAL METHODS IN SUBSURFACE FLOW,
GeoTrans, Inc., Reston, VA.
P. S. Huyakorn, and G. F. Pinder.
Academic Press, Inc., Orlando, Florida. 1983. 473p.

Descriptors: *Groundwater movement, *Unsaturated flow, *Model studies, *Mathematical studies, *Simulation analysis, Hydrologic models, Fracture permeability, Energy transfer, Finite element method, Mathematical equations, Reservoirs, Energy transfer, Finite difference methods, Numerical analysis, Solute transport.

The objective of this book is to provide an introduction to the various numerical approaches to the simulation of subsurface flow phenomena. A wide range of practical problems are examined, including groundwater flow, unsaturated flow, flow in fractured media, solute and energy transport, geothermal reservoir simulation, oil and gas reservoir simulation, and land subsidence. The major emphasis is placed on the finite element and finite difference methods that have proved to be powerful tools for solving differential equations usually intractable analytically. Other numerical techniques considered to be variants of the finite element and the finite difference methods are also presented. These include the collocation method, the boundary element method, and the method of characteristics. The book is divided into four basic parts. The first is devoted to fundamental concepts in numerical methods. Having developed the basic theory, the second part demonstrates how finite elements can be applied to a broad range of problems in groundwater hydrology and reservoir engineering. Alternative techniques related to finite elements and applicable to these problems are also included. The third and fourth parts deal with the finite difference theory and applications of this and other associated techniques to some of the problems for which the finite element method may not be optimal. In progressing from topic to topic, adequate background material concerning the physical concepts of subsurface phenomena is provided for readers who may be unfamiliar with this subject. (Lantz-PTT)
W89-05755

RECHARGE STUDIES IN THE WESTERN MURRAY BASIN: 1. RESULTS OF A DRILLING PROGRAM AT BORRIKA,
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Soils.
M. W. Hughes, P. G. Cook, I. D. Jolly, T. A. Beech, and C. T. Fieberger.
Technical Memorandum 88/10, August 1988. 47p, 22 fig, 15 tab, 4 ref.

Descriptors: *Groundwater basins, *Recharge, *Groundwater recharge, *Data collections, *Drilling, Australia, Groundwater budget, Dry forming, Groundwater quality, Chlorides, Particle size, Oxygen radioisotopes, Deuterium, Tritium.

This report presents the results of a drilling program carried out between July 1984 and February 1987 near Borrika, South Australia. The aim of the project was to study the small-scale spatial variability of groundwater recharge. The holes are located beneath mallee (Eucalyptus spp.) vegetation, and on land which was cleared 50 years ago, and has since been used for pasture and crops under a dryland farming regime. Samples were analyzed for water content, chloride, matric suction, particle size, oxygen-18, deuterium and tritium. (Author's abstract)
W89-05757

GROUNDWATER QUALITY: STATE ACTIVITIES TO GUARD AGAINST CONTAMINANTS.
General Accounting Office, Washington, DC.
For primary bibliographic entry see Field 5G.
W89-05765

MONTHLY STREAMFLOW AND GROUNDWATER CONDITIONS IN THE UNITED

STATES AND SOUTHERN CANADA, WATER YEARS 1945-85,
Geological Survey, Reston, VA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W89-05771

DIGITAL SIMULATION OF GROUND-WATER FLOW IN THE HIGH PLAINS AQUIFER IN PARTS OF COLORADO, KANSAS, NEBRASKA, NEW MEXICO, OKLAHOMA, SOUTH DAKOTA, TEXAS, AND WYOMING,
Geological Survey, Lakewood, CO. Water Resources Div.
R. R. Luckey, E. D. Gutentag, F. J. Heimes, and J. B. Weeks.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Professional Paper 1400-D, 1986. 57 p, 35 fig, 8 tab, 54 ref.

Descriptors: *Groundwater, *Computer models, *Groundwater movement, *Geohydrology, *Aquifers, *High Plains, Hydrology, Colorado, Kansas, Nebraska, New Mexico, Oklahoma, South Dakota, Texas, Wyoming.

The flow system in the High Plains aquifer was stimulated in three parts using two-dimensional models with a regular network of nodes spaced 10 miles apart in both the north-south and east-west directions. Predevelopment and development periods were simulated. In the predevelopment-period calibrations, the hydraulic conductivity and the recharge from precipitation were adjusted. In the development-period calibrations, which were from 20 to 40 years in length, return flow from pumpage and additional recharge due to human activities were adjusted. The estimated predevelopment net recharge ranged from 0.086 to 1.03 inches per year for the southern High Plains, 0.056 to 0.84 inches peryear for the central High Plains, and 0.076 to 1.52 inches per year for the northern High Plains. Significant adjustments to the estimated hydraulic conductivity values were made in all three areas. The calibrated predevelopment-period models provided the initial conditions for the development-period models. Two development-period calibrations based on water levels were made for the southern High Plains and one development-period calibration based on water level changes was made for the central and northern High Plains. For the southern High Plains, calibration was achieved when return flow was adjusted so that net withdrawal (total pumpage minus return flow) equaled 90 percent of the calculated irrigation requirement while for the central and northern High Plains, calibration was achieved when net withdrawal equaled 100 percent of the irrigation requirement. Two inches per year of the additional recharge were simulated in the southern High Plains, 47.0 million acre-feet of additional recharge from various sources were simulated during 1960-80. The calibrated development-period models will provide the initial conditions for projecting future water levels in the High Plains. (USGS)
W89-05774

FIELD APPLICATION OF PARAMETER IDENTIFICATION IN GROUNDWATER CONTAMINANT TRANSPORT MODELING: A CASE STUDY,
Washington Univ., Seattle. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W89-05781

WATER RESOURCES OF FREDERICK COUNTY, MARYLAND,
Maryland Geological Survey, Baltimore.
M. T. Duigon, and J. R. Dine.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. Maryland Geological Survey Bulletin 33, 1987. 106 p, 2 pl, 50 fig, 22 tab, 92 ref.

Descriptors: *Geohydrology, *Water resources, *Water availability, *Water quality, *Well yields, *Maryland, Surface water characteristics, Frederick County.

Ground water in Frederick County, Maryland, occurs primarily in fractures in crystalline and well-indurated sedimentary rocks. Reported well yields range from 0 to 950 gal/min, with a median of 10 gal/min. About 11% of the wells reportedly yield less than 2 gal/min. The range and median value of specific capacities are 0 to 263 and 0.15 gal/min/ft of drawdown, respectively. Transmissivities rarely exceed 1,000 ft sq/day. Over 60% of the wells inventoried were drilled for domestic use. Wells can be grouped by factors, such as geological unit, but within-group variation in yield remains large. The 7-day, 10-year low flow of streams in Frederick County range from no flow to 5.1 cu ft/sec. The greatest low flows per square mile tend to occur in the southern basins and the lowest in the northern basins. Ground and surface waters are calcium magnesium bicarbonate types. Trace metals and pesticides were found in low or undetectable levels. The average annual hydrologic budget for the county is: Precipitation (48 inches) + Incoming Streamflow and Underflow (13 inches) = Surface Runoff (25 inches) + Subsurface Runoff (11 inches) + Underflow Leaving the County (0 inches) + Evapotranspiration (25 inches) + Change in Storage (0 inches). (USGS)
W89-05785

SUBSURFACE GEOLOGY OF THE ST. CROIX CARBONATE SYSTEM, PHASE II,
College of the Virgin Islands, St. Thomas.
I. P. Gill, and K. Hubbard.
Available from National Technical Information Service, Springfield, VA 22161 as PB88-199914/AS, price codes: A05 in paper copy, A01 in microfiche. Virgin Islands Water Resources Research Center, St. Thomas, Technical Report No. 28, May 1987. 79 p, 14 fig, 24 ref, append. Contract 14-08-0001-G1258.

Descriptors: *Virgin Islands, *St. Croix Island, *Geologic formations, *Drill holes, *Subsurface geology, Aquifers, Geohydrology, Limestone, Carbonates, Stratigraphy.

Seven new test holes were drilled into St. Croix's central carbonate plain with a rotary drill rig. Cummulative drilling for this phase of the project exceeded 750 ft, and brought the total number of test holes for the project to fourteen. These test holes allow lithologic and biostratigraphic correlation in a north to south transect from Krausses Lagoon to Estate St. John and in a west to east transect from Estate Hessleberg to Estate Pearl. The drilling establishes the existence of a probable Pliocene reef and shallow-water facies trend that rims the western and southern coastlines of the central plain. Dolomitization in the Pliocene carbonates rims what was the coastline of Krausses Lagoon before industrial development modified the shoreline in the 1960's. Structural mapping on the upper surface of the Miocene Jealousy Formation indicates marked upwarping under the carbonate highlands. Micropaleontological evidence suggests that the Jealousy Formation/Kingshill Limestone contact is time-transgressive within the Miocene. (USGS)
W89-05787

MODELING TRANSIENT GROUND WATER FLOW IN MULTILAYERED AQUIFER SYSTEMS,
Georgia Inst. of Tech., Atlanta. School of Civil Engineering.
M. M. Aral, and E. H. Haddad.
Available from National Technical Information Service, Springfield, VA 22161 as PB88-202619/AS, price codes: A05 in paper copy, A01 in microfiche. Georgia Environmental Resources Center, Atlanta, Report ERC 05-86, April 1987. 69 p, 26 fig, 2 tab, 20 ref. Contract 14-08-0001-G1219. Project USGS G1219-02.

Descriptors: *Groundwater models, *Groundwater seepage, *Finite element method, *Multilayer aquifers, *Aquifer management, Model studies, Two-dimensional flow, Regional analysis, Flow equations.

The study is directed toward gaining additional knowledge on the unsteady performance of multilayer aquifers in response to heavy withdrawal of water from several wells distributed in the system. A recent status report on groundwater problems in South Eastern United States clearly indicates that more detailed information is needed on this problem in order to deacribe appropriate management options for such multilayer aquifer regions. In the first phase of this modeling effort which was published in 1985, steady state groundwater flow equations were studied and a steady groundwater flow model was developed for multilayer aquifers. The second phase of the study, reported here, extends the steady state model to an unsteady multilayer groundwater flow model which prepares the stage for contaminant transport model in multilayer aquifers which is the last phase of these model development efforts. A regional two-dimensional flow analysis is formulated using finite element techniques for multilayer aquifers. Numerical solutions are presented to test the accuracy and efficiency of the proposed technique. (Aral-GA Inst. Tech.)
W89-05790

2G. Water In Soils

STUDY OF INTERRELATED SOIL-WATER, GROUND-WATER AND RIVER FLOWS,
Akademiya Nauk SSSR, Moscow. Inst. Vodnykh Problem.
For primary bibliographic entry see Field 2E.
W89-04711

SEEPAGE COMPONENT IN WATER BALANCE OF PEAT SOILS,
Gdansk Technical Univ. (Poland). Inst. of Hyrdotechnics.
P. J. Kowalik, K. Banach, and I. Toczylowska.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu, Finland, 6-8 June 1988. Vol. 1. The Academy of Finland, Helsinki, Finland. 1988. p 178-183, 2 fig, 1 tab, 8 ref.

Descriptors: *Peat soils, *Soil water, *Wetlands, *Seepage, *Peat, *Hydrologic budget, *Peat bogs, Infiltration, Lysimeters, Soil moisture retention, Evapotranspiration, Soil water, Capillarity, Drainage systems, Poland.

Water seepage throughout the bottom of the soil profile is an important element in hydrological characteristics of peatland in the alluvial areas. This seepage was measured using lysimeter experiments in field conditions during several years. The components of the water balance equation are: the change in the soil water storage for a given period of time; the inflows, i.e. precipitation or surface infiltration and upward flow through the bottom of the soil; and the outflows, i.e. evapotranspiration and seepage through the bottom of the soil. The purpose of this research was to determine the amount of water coming from the peat soil into the groundwater (as deep seepage, also called efficient infiltration), or the amount of water coming from groundwater into the topsoil by capillary rise, and the influence of this water on the evapotranspiration. The upward seepage reached amounts from 45 mm during the growing season of a very wet year (1972) to 260 m during the growing season in the year with low rainfall (1975). These results proved, that for selected peat soils of the Fens of the delta of the Vistula River (North Poland) water supply of soil by upward seepage is about 30% of rainfall, and must be taken into account in the water balance and in the drainage system design. (See also W89-04689) (Author's abstract)
W89-04714

SOIL MOISTURE - GROUNDWATER RELATION IN THE FLOODPLAIN AREA OF THE DANUBE RIVER,
Vyskumny Ustav Vodohospodarsky, Bratislava (Czechoslovakia).
S. Gavenciak, and J. Lindtner.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu, Finland, 6-8 June 1988. Vol. 2. The Academy of Finland, Helsinki, Fin-

land. 1988. p 37-40, 2 fig, 3 ref.

Descriptors: *Danube River, *Soil water, *Groundwater recharge, *Flood plains, *Water table fluctuations, *Wetlands, Evapotranspiration, Soil moisture retention, Soil profiles, Forest watersheds, Czechoslovakia.

The occurrence of flood plain forest ecosystems is dependent on sufficient water storage in the soil profile, especially in the first half of the vegetation season. The time distribution of soil moisture and its dependence upon groundwater were investigated at the Danubian flood plain forests in southwestern Slovakia. Groundwater is recharged from the Danube River and its branches. At the average water stage, the water table fluctuates in sandy-loamy deposits covered by gravel sands. Distribution of moisture through the unsaturated zone also is a transient phenomenon, determined by the position of water table and actual evapotranspiration. During the predominant part of the vegetation season, from April till August, soil layers were saturated within the field capacity and full water capacity. If the water table fell in the depth more than 1.5 m, the values of moisture content in the root zone dropped below the field capacity. (See also W89-04731) (Author's abstract)
W89-04737

WATERSHEDS,
For primary bibliographic entry see Field 5B.
W89-04864

MOBILIZATION OF CU AND ZN IN CONTAMINATED SOIL BY NITRILOTRIACETIC ACID,
Pennsylvania State Univ., University Park. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 5B.
W89-04981

IMPACT OF AFFORESTATION ON THE SOIL SOLUTION CHEMISTRY OF STAGNOPODZOLS IN MID-WALES,
Institute of Terrestrial Ecology, Bangor (Wales). Bangor Research Station.
B. Reynolds, C. Neal, M. Hornung, S. Hughes, and P. A. Stevens.
Water, Air, and Soil Pollution WAPLAC, Vol. 38, No. 1-2, p 55-70,, March 1988. 2 fig, 7 tab, 37 ref.

Descriptors: *Soil solution, *Wales, *Forest soils, *Soil chemistry, *Podzols, *Acid rain, *Acidification, Acidic water, Hydrogen ion concentration, Aluminum, Afforestation, Stagnopodzols, Soil water, Acidic soils.

To facilitate and encourage further development of predictive acidification models, results from comparative studies of grassland and forest system in upland Wales are presented to highlight the importance of cation exchange, weathering and increased salt loading in determining the concentrations of Al and H(+) in soil waters. The results show that for similar stagnopodzol soils, soil water concentrations are different under grassland and forest vegetation. Concentrations of Al are between 1.5 and 3 times higher, and anion concentrations are 1.5 times higher, in the forest soil waters compared with the grassland. The results may also indicate that afforestation of a grassland catchment increases the rate of breakdown of Al bearing minerals, such as poorly crystalline to amorphous Al oxides and aluminosilicates. The features demonstrated for soil solution chemistry and exchangeable cation chemistry are now being identified at other locations in Wales. It is suggested that H(+) and Al relationships in the soil solution can be assessed by cation exchange processes. (Miller-PTT)
W89-04985

USE OF A CHEMICAL EQUILIBRIUM MODEL TO UNDERSTAND SOIL CHEMICAL PROCESSES THAT INFLUENCE SOIL SOLUTION AND SURFACE WATER ALKALINITY,
Illinois Univ., Urbana. Dept. of Forestry.
M. B. David, J. O. Reuss, and P. M. Walthall.
Water, Air, and Soil Pollution WAPLAC, Vol. 38, No. 1-2, p 71-83, March 1988. 2 fig, 6 tab, 19 ref.

Descriptors: *Water chemistry, *Model studies, *Soil chemistry, *Soil solution, *Surface water, *Alkalinity, *Chemical equilibrium, Forest watersheds, Spodosols, Acid rain effects, New York, Maine, Soil horizons, Carbon dioxide, Aluminum.

A chemical equilibrium model was applied to soil chemistry data (Spodosols) collected from 30 and 21 forested watersheds in New York and Maine, respectively, during the EPA Pilot Soil Survey. Chemistry data were evaluated between states using lumped series and within New York using three series (Adams, Becket, and Canaan). All New York horizons had soil characteristics that tend to cause lower solution alkalinity in comparison to Maine horizons. Negative alkalinities were produced in all E horizons (-69 to -37 micromol/L) at each of the pCO2 levels used (0.3 to 2%). All B horizons had negative alkalinities at low pCO2 levels, which became positive at higher levels, except for the Canaan B and New York Bh horizons, which were negative at all pCO2 levels. C horizons generated positive alkalinities (1 to 67 micromol/L) at most pCO2 levels. Results indicate the importance of water contact with different horizons and soil series in determining solution alkalinity. Because of degassing effects, solutions with a positive alkalinity will increase in pH after leaving the soil, whereas solutions with a negative alkalinity will remain at low pH (pH < 5.5) and cause the surface water to be acidic. Application of the model to soil chemistry data collected in the northeastern United States illustrates the importance of various factors such as pCO2, Al solubility, base saturation, and exchange coefficients in determining surface water chemistry. (Author's abstract)
W89-04986

CHLORINE 36 AND TRITIUM FROM NUCLEAR WEAPONS FALLOUT AS TRACERS FOR LONG-TERM LIQUID AND VAPOR MOVEMENT IN DESERT SOILS,
New Mexico Inst. of Mining and Technology, Socorro. Dept. of Geoscience.
F. M. Phillips, J. L. Mattick, T. A. Duval, D. Elmore, and P. W. Kubik.
Water Resources Research WRERAO, Vol. 24, No. 11, p 1877-1891, November 1988. 8 fig, 2 tab, 43 ref, 3 append. New Mexico Water Resources Institute grants 1423638 and 1423654.

Descriptors: *Soil water, *Deserts, *Solute transport, *Radioactive tracers, *Tritium, *Chlorine radioisotopes, Field tests, Fallout, New Mexico, Arid lands.

Chlorine-36 and tritium have been widely used as laboratory tracers for the advection and dispersion of anionic solutes and water, respectively. Advances in accelerator mass spectrometry have recently made possible the analysis of chlorine-36 in natural soil water samples. Field investigations analogous to the laboratory experiments can now be conducted. Pulses of chlorine-36 and tritium released into the atmosphere by nuclear weapons testing in the 1950s and 1960s serve as the tracers. This study reports chlorine-36 and tritium measurements on desert soil profiles from Mew Mexico. In both cases where the two tracers were measured in the same profile, the tritium bomb pulse had penetrated between 1 and 3 m, but much of the chlorine-36 was retained near the soil surface. In contrast, the laboratory experiments usually show more rapid movement of chlorine-36 than tritium due to the anion exclusion effect. The difference is attributed to the lower water content, fluctuating temperature gradients, and longer time scale of the field situation, which may enhance vapor movement of the tritiated water relative to solute advection of the chlorine-36. The spreading of the chlorine-36 and tritium pulses may be modeled by dispersivities ranging from 5 to 8 cm, much larger than most corresponding laboratory values. These larger apparent dispersivities are probably more a result of vertical velocity fields varying with depth and time than of soil heterogeneity. These results illustrate how the bomb pulse chlorine-36 and tritium can be useful links between laboratory solute transport studies and the corresponding field applications. (Author's abstract)
W89-05057

IMPROVEMENT TO THE ONE-STEP OUTFLOW METHOD FOR THE DETERMINATION OF SOIL WATER DIFFUSIVITIES,
Agricultural Coll. of Athens (Greece). Lab. of Agricultural Hydraulics.
J. D. Valiantzas, P. G. Kerkides, and A. Poulovassilis.
Water Resources Research WRERAO, Vol. 24, No. 11, p 1911-1920, November 1988. 12 fig, 15 ref.

Descriptors: *Soil water, *Diffusivity, *Groundwater movement, Mathematical analysis.

A simple, quick and reliable iterative method for the determination of the soil water diffusivity-volumetric water content (D-Theta) relationship, based on the outflow analysis was developed. This method imposes no restriction on the functional D(Theta) relationship and gives better results than other previous methods even in cases of extreme nonlinearities in the ln D(Theta) relationship and in cases where the D(Theta) relationship is not monotonous. This method, an improvement to the already existing methods, was verified against simulated and measured one-step pressure outflow data. (Author's abstract)
W89-05060

NEW FUNCTIONAL FORM FOR THE DISPERSIVE FLUX IN POROUS MEDIA,
California Univ., Livermore. Lawrence Livermore Lab.
For primary bibliographic entry see Field 2F.
W89-05063

ACID DEPOSITION AND NUTRIENT LEACHING FROM DECIDUOUS VEGETATION AND PODZOLIC SOILS AT THE TURKEY LAKES WATERSHED,
Great Lakes Forestry Research Centre, Sault Sainte Marie (Ontario).
For primary bibliographic entry see Field 5B.
W89-05092

EFFECTS OF SUBSURFACE DRAINAGE ON HEAVY HYDROMORPHIC SOIL IN THE NELINDVOR AREA, YUGOSLAVIA,
Institut za Vodoprivredu Jaroslav Cerni, Belgrade (Yugoslavia).
For primary bibliographic entry see Field 4C.
W89-05108

FRENCH PROGRAMME OF DRAINAGE REFERENCE AREAS: METHODOLOGY AND FIRST RESULTS,
Centre National du Machinisme Agricole, du Genie Rural, des Eaux et des Forets, Antony (France).
For primary bibliographic entry see Field 4A.
W89-05112

DRAINAGE CRITERIA FOR HEAVY SOILS WITH A SHALLOW IMPERVIOUS LAYER,
Instituto Nacional de Reforma y Desarrollo Agrario, Madrid (Spain).
For primary bibliographic entry see Field 4A.
W89-05116

HYDROLOGICAL RESPONSE OF A SILTY CLAY LOAM FOLLOWING DRAINAGE TREATMENT,
Seale-Hayne Coll., Newton Abbot (England). Dept. of Science.
For primary bibliographic entry see Field 4A.
W89-05120

PREFERENTIAL FLOW INFLUENCES ON DRAINAGE OF SHALLOW SLOPING SOILS,
New York State Coll. of Agriculture and Life Sciences, Ithaca. Dept. of Agricultural Engineer-

ing.
T. S. Steenhuis, T. L. Richard, M. B. Parlange, S. O. Aburime, and L. D. Geohring.
Agricultural Water Management AWMADF, Vol. 14, No. 1-4, p 137-151, August 1988. 6 fig, 34 ref.

Descriptors: *Soil porosity, *Groundwater movement, *Groundwater management, Hardpan, Flow discharge, *Drainage, *Slopes, *Agricultural hydrology, Soil water, Drainage systems, Tile drainage, Design criteria, New York, Hydraulic conductivity, Model studies, Subsoil, Heterogeneity.

The dramatic effect of flow through macropores and hardpan fissures on artificial drainage in shallow sloping soils was demonstrated. An assessment of the magnitude of macropore influences on solute transport can be attained by comparing the observed solute loss with the predictions of a homogeneous model. Shorter than expected travel times were strong evidence that macropores form an important conductor in water and solute transport. Where structured heterogeneities such as cracks existed, their influence on solute transport is often increased by associated biologically-formed pores which were disproportionately found in the less-dense areas of the soils. It was obvious from these studies that the 'standard' homogeneous theory as used in current drainage design is not valid especially if the soil is near saturation. The flow mechanisms discussed have been identified in field research during the last five years on shallow soils in Upstate New York. In designing drainage systems on these types of soils, more emphasis should be given to the characteristics of the hardpan. Subsoil is the most important factor in considering what kind of drainage system is required. The conductivity of the soil above the hardpan is of little consequence as long as there is a well-developed macropore system, that can conduct the water to the layers beneath. While drainage systems have often been installed in a manner consistent with the concepts of preferential flow, there has been little success to date in incorporating these concepts into theoretical formulations. The variety and variability of preferential flow phenomena challenge efforts to develop useful mathematical models of water movement in heterogeneous soil. In the interim, a greater emphasis on subsoil macropore hydrology will hopefully lead to more effective drainage designs. (Vernooy-PTT)
W89-05121

EFFECT OF SWELLING AND SHRINKAGE ON THE CALCULATION OF WATER BALANCE AND WATER TRANSPORT IN CLAY SOILS,
Institute for Land and Water Management Research, Wageningen (Netherlands).
J. J. B. Bronswijk.
Agricultural Water Management AWMADF, Vol. 14, No. 1-4, p 185-193, August 1988. 6 fig, 20 ref.

Descriptors: *Groundwater movement, *Soil water, *Agricultural hydrology, *Swelling, *Shrinkage, *Clay, *Hydrologic budget, Soil properties, Hydrologic models, Model testing, Simulation analysis, Soil surfaces, Drainage engineering, Hydraulic conductivity, Subsidence, Path of pollutants, Cracks, Water table, Precipitation.

Volume changes and resulting shrinkage cracks are of great importance for water transport in clay soils. Therefore these processes should be taken into account when applying soil water simulation models to such soils. A general procedure is outlined to model the water balance of clay soils. The main feature of this procedure is the introduction of the shrinkage characteristic into simulation models in addition to water retention and hydraulic conductivity curves. With the aid of shrinkage characteristics and additional assumptions concerning geometry of swelling and shrinkage, bypass flow, crack-volume and surface subsidence of clay soils are calculated. The effects of swelling and shrinkage on water transport are shown by comparing calculations of a model for rigid soils (FLOWEX), a model for cracking soils (FLOCR) and field measurements. Bypass flow as calculated with FLOCR amounted to 28% of precipitation, which resulted in a drier top soil, a higher groundwater table with very rapid response after precipitation events, and a higher drain outflow in the cracking-soil model. The good correspondence between results of FLOCR and field measurements of groundwater levels supports the use of this model in clay soils. The effects of cracks are unfavorable with respect to crop water availability and transport of pollutants to subsoil, drains and surface water. However, cracks can also have favorable effects. For instance, the number of days at which the soil had insufficient bearing capacity for grazing cattle decreased from 63 to 28 when swelling and shrinkage were taken into account. (Author's abstract)
W89-05125

SIGNIFICANCE OF SOIL SURVEY FOR AGROHYDROLOGICAL STUDIES,
International Inst. for Land Reclamation and Improvement, Wageningen (Netherlands).
J. M. H. Hendrickx, L. W. Dekker, M. H. Bannink, and H. C. van Ommen.
Agricultural Water Management AWMADF, Vol. 14, No. 1-4, p 195-208, August 1988. 7 fig, 1 tab, 47 ref.

Descriptors: *Soil water, *Agricultural hydrology, *Soil surveys, *Wetting, *Solute transport, The Netherlands, Seepage, Surveys, Fens, Wetlands, Soil science, Soil physical properties.

We present two examples of agrohydrological studies in the Netherlands as an illustration of cooperative research between soil scientists and agrohydrologists. The first deals with wetlands: determination of seepage from a fen. It is shown that for agrohydrological studies a soil survey is not completed unless soil physical measurements have been made for all major horizons in an area. It is also argued that a sensitivity analysis should be carried out to determine with which accuracy horizon thickness must be measured during the soil survey. The second example deals with effect of unstable wetting fronts on water and solute transport. Field data obtained with an iodide coloring technique showed that unstable wetting fronts cause preferential flow paths for water and solute transport. The study demonstrated that occurrence of unstable wetting fronts can be foreseen through interpretation of qualitative soil survey data. (Author's abstract)
W89-05126

PROSPECTS OF SOIL MOISTURE CONSERVATION BY FALLOWING IN AREAS OF MEDIUM AGRICULTURAL POTENTIAL IN SMALLHOLDER FARMING,
National Agricultural Labs., Nairobi (Kenya).
For primary bibliographic entry see Field 3F.
W89-05132

READJUSTING THE WATER BALANCE TO COMBAT DRYLAND SALTING IN SOUTHERN AUSTRALIA: CHANGING THE HYDROLOGY OF A TEXTURE CONTRAST SOIL BY DEEP RIPPING,
Land Protection Service, Bendigo (Australia).
For primary bibliographic entry see Field 3C.
W89-05134

INFLUENCE OF SUB-SOIL ON THE MOISTURE REGIME IN IRRIGATED FIELDS,
Southampton Univ. (England). Inst. of Irrigation Studies.
G. A. Ghali, and Z. J. Svehlik.
Agricultural Water Management AWMADF, Vol. 14, No. 1-4, p 307-316, August 1988. 5 fig, 2 tab, 13 ref, append.

Descriptors: *Subsoil, *Moisture availability, *Soil water, *Irrigation efficiency, Moisture content, Root zone, Soil-water-plant relationships, Numerical analysis.

Very often, the analysis of soil moisture depletion for irrigation scheduling is undertaken on the assumption that the root zone is in isolation from the sub-soil. In this simplistic approach, it is presumed that the soil moisture conditions below the root zone have no bearing on estimates of actual water depletion from the root zone. The merits of the suggested numerical analysis are demonstrated by the results in a complete irrigation season on a medium textured soil, and an evaporative demand of 6.0.mm/d, with 10% of this value assumed to represent the potential surface evaporation. Irrigation water is applied when the relative transpiration is 85%. The components of the root zone water balance and the impact of the sub-soil on the irrigation intervals can be accurately estimated. The latter decreases during the late growing stages, due to upward moisture flux. The effect of cyclic wetting and drying and the eventual replenishment of the moisture reservoir in the sub-soil resulted in an increase in the irrigation intervals by as much as 30% in the last cycle, over those in the earlier cycles. The results show the possible errors that can be committed in irrigation scheduling, as well as in calculations of the water use and crop yield projections, when the transfer of water through the lower boundary of the root zone is ignored. (Vernooy-PTT)
W89-05136

FIELD VALIDATION OF AN EMPIRICAL SOIL WATER MODEL,
Imperial Coll. of Science and Technology, London (England). Dept. of Civil Engineering.
S. S. Nwabuzor.
Agricultural Water Management AWMADF, Vol. 14, No. 1-4, p 317-327, August 1988. 5 fig, 2 tab, 20 ref.

Descriptors: *Hydrologic models, *Soil water, *Moisture profiles, *Model testing, *Moisture content, Field tests, Simulation analysis, Numerical analysis.

An empirical single layer soil water model was assessed by comparison with field data. The model gives reasonable simulation of soil moisture when expressed as a deficit with respect to field capacity. The simulations are shown to be improved if the available water capacity and root constant values are allowed to vary for different years. However, the model fits are shown to be limited by the conceptual basis of the model which does not recognize the existence of simultaneous deficit and drainage. The concept of a single field capacity to represent a dynamic soil water profile is shown to explain the model deficiency. It is concluded that the simulation can be improved if field capacity determination is modified to include the drainage term, which can be achieved by a multilayer model. (Author's abstract)
W89-05137

PHOSPHORUS CONCENTRATION TRENDS IN THE SALINE RIVER WATERSHED, USA,
Queen's Univ., Kingston (Ontario). Dept. of Biology.
M. G. Fox, and A. M. Beeton.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IV TLAP, Vol. 23, No. 2, p 1119-1124, August 1988. 1 fig, 5 tab, 9 ref.

Descriptors: *Water pollution prevention, *Agricultural runoff, *Phosphorus removal, *Model studies, *Best management practices, Sediments, Saline River, Michigan, Row crops.

Water quality data from nine monitoring stations in the Saline Valley Rural Clean Water Project area, Michigan, were analyzed to determine if agricultural Best Management Practices were reducing total phosphorus, soluble reactive phosphorus and available phosphorus concentrations in the watershed. Data from a pretreatment year and two progressive treatment years were compared, using a covariate analysis model to correct for differences in discharge between years. Significant decreases in phosphorus concentration from years one or two to year three occurred in 13 of the 27 comparisons. Soluble reactive phosphorus showed the most significant decreases. However, large increases in row crop acreage from years two to three may have masked the effectiveness of Best Management Practices in reducing concentrations

of sediment bound phosphorus in the water. (Author's abstract)
W89-05198

SATURATED SOIL HYDRAULIC CONDUCTIVITY IN LOBLOLLY PINE PLANTATIONS ON DRAINED SITES,
Raleigh, NC.
For primary bibliographic entry see Field 2F.
W89-05264

SOIL SOLUTION CHEMISTRY IN LODGEPOLE PINE (PINUS CONTORTA SPP. LATIFOLIA) ECOSYSTEMS, SOUTHEASTERN WYOMING, USA,
Cornell Univ., Ithaca, NY. Dept. of Natural Resources.
T. J. Fahey, and J. B. Yavitt.
Biogeochemistry, Vol. 6, No. 2, p 91-118, 1988. 5 fig, 5 tab, 48 ref. NSF Grants DEB 78-05311, DEB 80-11024, DEB 81-13546, and BSR 83-01842.

Descriptors: *Root zone, *Soil water, *Forest soils, *Soil chemistry, *Forest hydrology, *Inorganic compounds, *Pine trees, Hydrogen ion concentration, Trace elements, Calcium, Magnesium, Potassium, Sodium, Saturation zone, Sulfates, Bicarbonates, Snowmelt, Aluminum, Iron.

Concentrations of the principal inorganic and organic solutes in the soil root-zone were measured in six contrasting lodgepole pine (Pinus contoria ssp. latifolia) forest ecosystems for five years (1979-1983). Consistent temporal changes in the principal inorganic solutes (Ca, Mg, K, Na, SO4, Cl) were observed in all the forest stands and years of study: high concentrations at the initiation of snowmelt in the spring were followed by rapid declines to rather constant values in the mid to late stages of snowmelt. Except for K, concentrations of these solutes differed significantly between sites and between years. Sulfate was the principal mobile anion in the root-zone soil solutions, but contributions of bicarbonate and organic anions also were important. The pH of root-zone solutions was relatively high (6.0), did not change significantly as snowmelt proceeded, and was significantly lower in high-clay soils. No consistent trends in bicarbonate alkalinity were observed and soil atmosphere CO2 concentrations were only about 10 to 20 times above atmospheric levels, peaking at the end of the snowmelt interval. Concurrent changes in the concentrations of dissolved organic carbon, non-volatile acid-neutralizing capacity, and total Al and Fe indicated that these soil-forming metals were transported vertically in the soil as organic complexes. Precipitation of these complexes was more rapid and more complete in the soils with high clay content than in coarser soils. Moreover, organic anions comprised up to 30% of the total anionic charge in the coarse-textured soils but less than 10% in the fine soils. Little seasonal or spatial variation of inorganic N and P concentrations was observed in root-zone solutions, probably as a result of high biotic demand for these limiting nutrients. Flux of N and P in these ecosystems was predominately via organic forms so that losses of these nutrients was strongly linked to the mobility of dissolved organic carbon. However, a two-fold increase in the organic N:P and C:P ratios was observed during passage of melt water from the forest floor to mineral soil, evidence of more rapid mineralization of organic P. (Author's abstract)
W89-05327

HEAT AND MASS TRANSFER IN UNSATURATED POROUS MEDIA WITH APPLICATION TO THERMAL ENERGY STORAGE,
Technion - Israel Inst. of Tech., Haifa.
J. Bear, A. Nir, and J. Bensabat.
IN: Groundwater Flow and Quality Modelling. D. Reidel Publishing Co., Boston. 1988. p 57-73, 3 fig, 13 ref.

Descriptors: *Mass transfer, *Unsaturated flow, *Heat storage, *Heat transfer, *Groundwater movement, *Porous media, Temperature, Vapor, Heat storage, Aeration zone, Soil properties, Conductivity, Drying, Energy.

A model of heat and mass transfer in the unsaturated zone, is presented, taking into account the effect of a temperature gradient on the advective water flux and of enhanced thermal conduction by the processes of latent heat transfer with the vapor flow. The flow of the vapor is enhanced by its transfer through the water phase following a process of simultaneous evaporation and condensation at the air water interfaces. The motivation for the study is to provide the information required for planning heat storage in the unsaturated zone, especially information is required on the possibility of drying near the heat input boundary. The study shows that the considered system is unstable, with the occurrence of drying depending on the initial and boundary conditions. For given boundary conditions of heat transfer, there are initial conditions of water content for which heating will not cause significant drying. Therefore, fine soils may be better suited for heat transfer at the boundaries, due to their higher field capacity, although their heat conduction coefficients are lower than those of sandy soils. At present, these conclusions are limited to the range of 50 C to 70 C. (See also W89-05465) (Author's abstract)
W89-05468

ADVANCES IN MODELING OF WATER IN THE UNSATURATED ZONE,
Princeton Univ., NJ. Dept. of Civil Engineering.
P. C. D. Milly.
IN: Groundwater Flow and Quality Modelling. D. Reidel Publishing Co., Boston. 1988. p 489-514, 29 ref.

Descriptors: *Soil water, *Aeration zone, *Model studies, *Groundwater movement, Mathematical models, Hydraulic models, Simulation analysis, Mathematical studies, Homogeneity, Heterogeneity.

Recent advances in the modeling of water flow in the unsaturated zone are reviewed. The Richards model remains the most widely accepted and fertile framework for water flow analyses. More general formulations are reserved for the analysis of problems involving macroporosity, thermal effects, and air pressure effects. Many exact and approximate solutions have been derived for particular boundary value problems of homogeneous soils using method such as quasi-linear analysis, Green-Ampt analysis, perturbation, and the kinematic wave approximation. Numerical simulators have become bigger and more accurate due to improvements in the areas of nonlinear solution procedures, mass conservation, computational efficiency, and computer hardware. Problems of natural heterogeneity have been addressed primarily through the application of various stochastic methods to the Richards model. The stochastic formulations generally refute the concept of simple 'equivalent' homogeneous properties, but do themselves offer a certain limited potential for a predictive capability. (See also W89-05465) (Author's abstract)
W89-05493

WINNING WITH WATER: SOIL-MOISTURE MONITORING FOR EFFICIENT IRRIGATION,
INFORM, Inc., New York.
For primary bibliographic entry see Field 3F.
W89-05542

EVALUATION OF A SUGGESTED SEQUENCE FOR THE CHEMICAL EXTRACTION OF SOLUBLE AMORPHOUS PHASES FROM CLAYS,
For primary bibliographic entry see Field 7B.
W89-05597

EFFECT OF SOIL DISPERSION ON SURFACE RUN-OFF IN SOUTHERN PIEDMONT SOILS,
Georgia Univ., Athens. Dept. of Agronomy.
D. E. Radcliffe, W. P. Miller, and S. C. Chiang.
Available from National Technical Information Service, Springfield, VA 22161 as PB88-202601/AS, price codes: A03 in paper copy, A01 in microfiche. Georgia Environmental Resources Center, Atlanta, Report ERC 01-87, March 1987. 28 p, 6 fig, 6 tab, 9 ref. Contract 14-08-0001-G1219. Project USGS G1219-04.

Descriptors: *Soil dispersion, *Lateral flow, *Flocculation, *Soil erosion, *Infiltration, *Permeability, Piedmont soils.

Lateral movement of infiltrating water frequently occurs at the surface of Southern Piedmont soils andmay occur below the surface when dense layers are present at a shallow depth. The objective was to determine to what extent lateral movement occurred and what mechanisms might be responsible for the low permeability. Because of equipment problems with a field rainfall simulator we were unable to address subsurface lateral flow, but a greenhouse and laboratory experiment provided information on surface lateral flow. In Experiment I, infiltration rates declined steadily in three soils, two of which had final infiltration rates so low that run-off would occur under all but very low intensity rainfalls. The decline in infiltration was attributed to dispersion of soil particles upon impact by raindrops and the formation of a low permeability washe-in layer of dispersedd clay particles just below the surface. In Experiment II, it was shown that soil dispersion varied among soils and could be severe when infiltrating water was low in mineral content (eg. rainfall) and soil pH had been raised through liming. (Radcliffe-Univ. GA)
W89-05791

2H. Lakes

HYDROLOGY OF THE DEVILS LAKE BASIN, NORTHEASTERN NORTH DAKOTA,
Geological Survey, Bismarck, ND. Water Resources Div.
G. J. Wiche, S. M. Hoetzer, and J. G. Rankl.
North Dakota State Water Commission Water-Resources Investigations Report 3, 1986. 86p, 17 fig, 13 tab, 64 ref, 2 append.

Descriptors: *Hydrologic studies, *Devils Lake, *Water resources data, North Dakota, Water level, Runoff, Climates, Lake morphology, Simulation analysis, Lakes.

Since 1867, the water level of Devils Lake has fluctuated from 1,438 ft above sea level in 1867 to 1,400.9 ft above sea level in 1940. Analysis of the available hydrologic and climatologic data indicates the water level of Devils Lake fluctuates largely in response to climatic variability. Computed average annual inflow has varied from 70,000 acre-ft for 1969-83 to as little as 4,530 acre-ft for 1931-40. In addition to the effects of climatic variability on the inflow to Devils Lake, an interconnected chain of lakes upstream of Devils Lake retains runoff and is an evaporation basin for runoff from the Devils Lake basin. During 1965-67, at least 112,000 acre-ft of water was stored in this upstream chain of lakes. The higher the water level of Devils Lake, the greater the inflow required to raise the water level a given increment. Based on a starting water level of 1,426.1 ft above sea level and an inflow of 72,200 acre-ft, the lateral change in shoreline location ranges from 16.8 ft along the south shore of Devils Lake and along the shore of Creel Bay to 148 ft along the West Bay of Devils Lake near Minnewaukan Flats. Based on previously recorded hydrologic and climatologic data, a 'high-runoff' and a 'low-runoff' condition were simulated from 1985 through 1990, assuming the cui ent (1985) water level for the initial lake stand. The 'high-runoff' simulation indicates that Devils Lake would have a maximum water level of 1,431.43 ft above sea level. The 'low runoff' simulation indicates that Devils Lake would have a minimum water level of 1,420.69 ft above sea level. (Lantz-PTT)
W89-04637

LONG-TERM STAGE RECORDS OF LAKES IN FLORIDA,
Geological Survey, Tallahassee, FL. Water Resources Div.
D. W. Foose.

U.S. Geological Survey Map Series 118, 1987. 1p, 1 tab, 4 maps, 10 ref.

Descriptors: *Water resources data, *Maps, *Lakes, *Data collections, *Florida, *Lake stages, Hydrologic studies, Water quality, Limnology, Reservoirs.

Florida has at least 7,800 lakes, far more than most other states. They are valued as attractive places to live near and for recreation, but they also are valuable as sources of water for agriculture, industry, and public or private utilities. To determine trends and rates of change, long-term records of stage and water quality have been collected on 233 lakes - generally larger lakes or lakes of special value because of their location or uses. This map report indicates, by use of triangles, the locations of the 233 lakes for which 10 or more years of stage data were collected. The color of the triangle indicates the number of years of record. The locations are numbered from north to south by the latitude and longitude of the stations. That number is the 'Map Reference' in the first column of a table which indicates the name of the lake, a nearby city, years of record, period and frequency of data collection, surface area, rank by size, if the lake is a manmade reservoir, and if the lake was meandered during the original State surveys. The size of each lake in the table is shown both in acres of surface area at normal elevations and in a ranked order in relationship to all other named lakes in the State from the largest to the smallest. Because all lakes were considered, the numbers are not sequential and become increasingly approximate for lakes with a surface area smaller than 200 acres. (Lantz-PTT)
W89-04639

LIMNOLOGICAL STUDY OF LAKE BRUIN, LOUISIANA,
Geological Survey, Baton Rouge, LA. Water Resources Div.
C. R. Demas.
Louisiana Department of Transportation and Development, Baton Rouge, Water Resources Technical Report No. 38, 1985. 96p, 31 fig, 20 tab, 40 ref.

Descriptors: *Water pollution sources, *Eutrophication, *Limnology, *Lake *Water quality, Bruin, Louisiana, Algae, Productivity, Rainfall, Runoff, Calcium bicarbonate, DDT, Insecticides, Dieldrin, Chlordane, Invertebrates, Eutrophic lakes, Limiting nutrients, Nitrogen, Phosphorus, Recreation, Drinking water.

A limnological study of Lake Bruin, an oxbow lake in northeastern Louisiana, was conducted from June 1980 to December 1982 to define limnological processes of the lake and to determine the extent of contamination from domestic sewage and pesticides. Lake Bruin was found to be a monomictic lake that stratified thermally in its deeper areas by mid-April and generally overturned during the last week in October. Dissolved oxygen concentrations in the hypolimnion approached 0.0 mg/L by April and remained low until after the fall overturn. Major sources of inflow to the lake during the study were rainfall and runoff. There was little input to the lake from groundwater. No hydraulic connection with the Mississippi River was observed. Water in Lake Bruin is good quality. Concentrations of all major ions in the calcium bicarbonate water were relatively low. Pesticides and minor elements were present in the water in very low concentrations. However, insecticides such as DDT, DDD, dieldrin, and chlordane were found in relatively high concentrations in samples from bottom material and fish-tissue samples. Productivity in Lake Bruin was high; however, net productivity was usually restricted to the upper 6.6 ft of water. Respiration often exceeded primary production below a depth of 6.6 ft. Algae common in Lake Bruin were Lyngby, Oscillatoria, Anacystis, Cyclotella, Melosira, Ankistrodesmus, and Dictyosphaerrium. Blue-green algae dominated the phytoplankton community during the summer. Nitrogen-phosphorus ratios indicated nitrogen was the potential limiting nutrient during some blue-green algae blooms; phosphorus appeared to be limiting at other times. Dominant benthic invertebrates were Chaoborus, Chironomus, Potamothrix, Limnondrilus, and unidentified tubificid worms. All are tolerant of low dissolved-oxygen concentrations. Physical, chemical, and biological data indicate that Lake Bruin is eutrophic. However, its trophic condition has not yet progressed to a level that interferes with its use for primary and secondary recreation or as a source for domestic drinking water. (Lantz-PTT)
W89-04660

REELFOOT LAKE. AN ASSESSMENT FOR WATER LEVEL MANAGEMENT.
Tennessee Wildlife Resources Agency, Nashville. April 1985. 38p, 11 fig, 20 tab, 100 ref, 9 append.

Descriptors: *Lakes, *Lake fisheries, *Drawdown, *Water resources management, *Tennessee, *Reelfoot Lake, *Water level, *Ecological effects, Fisheries, Recreation, Odor control, Fishing, Agriculture, Dredging, Economic aspects, Social aspects, Lake restoration.

Reelfoot Lake is a natural lake located in the extreme northwest corner of Tennessee. The lake covers approximately 15,500 acres at normal pool with 13,000 acres of open water. Reelfoot Lake is renowned for its abundance of fish and wildlife resources, providing an estimated annual use of 50,000 fishing trips, 21,310 hunting trips and 112,000 wildlife observation trips. These trips have an estimated value of $4,166,330. Trends at Reelfoot Lake since the 1950's, however, have indicated that the lake is degrading as a sport fishing resources. Several factors such as silt, pesticides and fertilizer from watershed erosion, and isolation from the Mississippi River are considered detrimental to the Reelfoot Lake fishery. However, a major factor that has a negative impact on the fishery is associated with a long history of relatively stable water levels at the lake. Several alternatives are considered to improve the lake bottom for favorable fish habitat including: (1) no action; (2) flushing by a water source from the Mississippi River; (3) large scale dredging; and (4) drawdown. Only large scale dredging and drawdown would result in the improved bottom conditions needed for significant physical and biological restoration of Reelfoot Lake. Of these, dredging was prohibitively expensive costing $53.7 million; therefore, drawdown was selected as the logical alternative. Adverse impacts of the drawdown alternative on desired biological communities are considered temporary since these species are common and their populations are substantial to replenish the ecosystem. Several adverse socioeconomic impacts are apparent or possible the year of the drawdown: (1) odor and esthetics; (2) recreation (other than hunting and fishing); (3) hunting and trapping; (4) recreational fishing; (5) commercial fishing; and (6) agriculture. Recreational fishing contributes most to the economics of the Reelfoot Lake community. The drawdown would occur during a period when fishing activity is the lowest; 70% of the fishing trips occur from January through June, and 30% from July through December (lake access would not be difficult until about July 1). Fishing trips are expected to increase from 50,000 to 65,000 trips annually as a result of drawdown; concomitantly, the annual economic values of fishing are expected to increase from $2,050,000 to $2,665,000. (Lantz-PTT)
W89-04662

PROCEEDINGS OF THE INTERNATIONAL SYMPOSIUM ON THE HYDROLOGY OF WETLANDS IN TEMPERATE AND COLD REGIONS.
Joensuu, Finland, 6-8 June 1988. Vol. 1. The Academy of Finland, Helsinki, Finland. 1988. 320p.

Descriptors: *Conservation, *Hydrology, *Wetlands, *Peat bogs, *Water quality management, *Environmental protection, Preservation, Runoff, Snowmelt, Models, Vegetation effects, Finland, Peat soils, Streamflow, Soil water, Hydrologic budget, Sedimentation, Acidic water, Forest management, Clear-cutting.

The proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions, held in Joensuu, Finland on 6-8 June, 1988 are presented. In the first section, initiatives in the conservation of wetlands in Canada, Finland, and Poland are examined. In the second section topics of swamp formation, mires, wetland resources, temperature changes in wetlands, peat water chemistry, artificial wetlands, and snowmelt and runoff in mires are presented. In the third section the following topics are discussed: seasonal variation in streamflow; peatlands influence on maximum flow; increasing drained peatland lifetime; the Nurmes-study; effects of clear-cutting; runoff in drained peatlands; runoff models; hydrologic budgets; soil water and groundwater flows; evapotranspiration effects on peatland water tables; water management in disturbed bogs; seepage component in water balance of peat soils; ditching; and effects of forest drainage on groundwater table levels and stream water quality. In the fourth section, the topics considered include: impacts of drainage for forestry on runoff and water chemistry; effects of clear-cutting on water quality in the Nurmes study; organic carbon dynamics in small brooks before and after clear-cutting and forest drainage; the modification of water quality in Ivujivik; effects of silvicultural measures on primary production in forest brooks; effects of harvesting on Phragmites production in wetlands; short-term changes in vegetation on pine mires after drainage for forestry; peat siltation from intensive peatland exploitation in Ireland; mole drainage experiments at a peat harvesting site; peatland forestry management and fuel peat mining in Finland; peatland development operations in Canada; paleolimnology of two Finnish lakes with recent field- and forest-ditch erosion sediments; sedimentation in the oldest reservoir in Finland; sources of acidity in humic lakes; and the influence of drainage and development of overwetted lands on quantitative and qualitative natural water indices. (See W89-04690 thru W89-04730) (Geiger-PTT)
W89-04689

CANADA'S WETLANDS: A NATIONAL WETLANDS CONSERVATION INITIATIVE,
Department of the Environment, Ottawa (Ontario). Lands Conservation Branch.
C. D. A. Rubec.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu, Finland, 6-8 June 1988. Vol. 1. The Academy of Finland, Helsinki, Finland. 1988. p 1-4, 11 ref.

Descriptors: *Environmental policy, *Management planning, *Wetlands, *Conservation, *Canada, *Acid rain, Monitoring, Environmental protection, Land use, Policy making, Marsh management, Maps.

Since mid-1986, Environment Canada has greatly expanded its leadership role in developing a national wetlands conservation initiative. With 24% of the world's wetlands, Canada has an international responsibility in this field. Steps taken include publication of comprehensive national perspectives on wetlands in the form of a (1) major reference book 'Wetlands of Canada,' (2) a map folio on wetland regions and distribution in Canada, (3) a Canadian wetlands classification system, and completion of research directed at wetland land use monitoring, economic valuation, and impacts of acid rain on wetlands. In parallel, a federal wetlands policy and a federal-provincial wetlands policy framework are being completed with strong participation by non-government groups and various levels of government. Environment Canada initiated a wetlands policy strategy in late 1986. After an initial phase exploring and defining the specifics of wetlands issues, a workshop seeking the input and opinion of non-government organizations was organized in February 1987. This involved representatives of wildlife conservation groups, naturalists, nature trusts, farmers, peat harvesters, science groups, hunters and trappers, and anglers. Subsequently, federal and provincial government officials from across Canada have met and accepted wetlands conservation as a national land use issue. National systems of wetland reserves are not common. Finland has recognized the value of this approach and undertaken establishment of peatland reserves

within its national parks system. A parallel proposal is now emerging in Canada. A Canadian Wetland System would be a key component in Canada's national conservation strategy in the decade before us. (See also W89-04689) (Geiger-PTT)
W89-04690

WETLAND CONSERVATION IN FINLAND,
Ministry of the Environment, Helsinki (Finland).
A. Haapanen, S. Eurola, P. Rassi, and P. Salminen.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu, Finland, 6-8 June 1988. Vol. 1. The Academy of Finland, Helsinki, Finland. 1988. p 5-9, 7 ref.

Descriptors: *Peat bogs, *Wetlands, *Marsh management, *Finland, Preservation, *Drainage effects, Wildlife conservation, Ponds, Environmental protection, Environmental policy.

In Finland the main wetland types are peatlands, marshy lakes and sea bays and oligotrophic and dystrophic ponds. In recent decades 53% of the peatlands have been drained mostly for forestry purposes. A high proportion of the marshy lakes and bays has been lowered in forestry improvement programs. National park and peatland preservation programs cover 0.7 million hectares of peatlands and 600 different areas. Most of these peatlands have been protected. The preservation program of marshy wetlands covers about 300 different areas and an area of 84,000 ha. Only a minor part of these areas has been protected. There are only few endangered or vulnerable species in Finland dependent on different types of wetlands. (See also W89-04689) (Author's abstract)
W89-04691

MULTIOBJECTIVE APPROACH TO WATER MANAGEMENT SYSTEM FOR WETLANDS IN BIEBRZA RIVER VALLEY: CASE STUDY,
Institute for Land Reclamation and Grassland Farming, Raszyn (Poland).
H. Okruszko, J. Szuniewicz, and T. Okruszko.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu, Finland, 6-8 June 1988. Vol. 1. The Academy of Finland, Helsinki, Finland. 1988. p 10-15, 1 fig, 3 ref.

Descriptors: *Multiobjective planning, *Peat bogs, *Marsh management, *Poland, *Wetlands, *River basins, Land use, Reclamation, Preservation, Case studies, Mires, Drainage effects, Computer models, Irrigation requirements, Water demand, Water management, Grasslands, Forest management.

A preliminary attempt has been made to develop a water management program for the Biebrza River Valley of Poland. This wetland territory is not reclaimed but partly drained due to some changes in natural hydrographic networks caused by the building of several canals in the 19th century. The areas in the valley of the middle Biebrza river have been divided into five types of sites: (1) the Red Bog reservation, a complex mire of transition and high moor, (2) areas surrounding the birch forests, (3) large consolidated complexes of birch forests, (4) grassland for agricultural use requiring irrigation, and (5) grassland for agricultural use without irrigation. In two of the five selected areas of the river valley, the water conditions are appropriate to levels of utilization. In three other areas, water conditions must be adjusted to the requirements associated with the methods of their planned management. The areas surrounding the Red Bog have been partially drained and designed for protection as wetlands. They must undergo renaturalization by increasing water inflow into these areas and by raising the groundwater level. This can be accomplished by raising the level of water and decreasing its outflow in the rivers Elk and Jegrznia and the canal joining them. Birch forests may also require water regulation due to evapotranspiration under the forest ecosystem. Grasslands will also require water management and a water balance involving probable deficiency of water from precipitation has been made on the basis of the meteorological conditions. An analysis of the water reserves and requirements in the Biebrza River Valley has shown that by utilizing water from the winter season all water demands can be met. Mathematical models have been used to regulate the water relations in the valley according to the needs of different ecosystems. Systematic observations of meteorological and hydrological conditions are required to make further calculations for water management in the Biebrza River Valley. (See also W89-04689) (Geiger-PTT)
W89-04692

ANALYSIS OF PRINCIPAL COMPONENTS FOR SWAMP FORMING FACTORS IN HENGDUAN MOUNTAINS,
Changchun Inst. of Geography (China). Dept. of Swamp.
Z. Wenfen.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in temperate and Cold Regions. Joensuu, Finland, 6-8 June 1988. Vol. 1. The Academy of Finland, Helsinki, Finland. 1988. p 16-23, 1 fig, 5 tab, 4 ref.

Descriptors: *Principal component analysis, *Subtropic zone, *Wetlands, *Swamps, *Peat bogs, *Marshes, *China, Climate, Data processing, Correlation analysis, Mathematical studies, Precipitation, Humidity, Altitude, Geology, Geomorphology, Geography.

Conditions for the formation of peat swamp in the Hengduan Mountains of the Qinghai-Xizang Plateau in China are analyzed. The results of the analysis show that the rise in altitude of the Qinghai-Xizang Plateau which evolved during the Quaternary era, especially since the Holocene era, allowed the horizontal zonality to be replaced and covered by vertical zonality. As a result, a vast expanse of swamp formed under the conditions of low temperature in this area of subtropic climate. The climatic, geological and geomorphological conditions are explored in relation to the formation of the swamp and peat deposit which is one of the richest peat resources in China. The formation of peat and swamp is analyzed along with the principal components for swamp-forming factors in this area. A cluster analysis of the swamp system is given for five categories in the Hengduan Mountains: plateau-flood land of river or lakeshore swamp area, swamp area mainly supplied (irrigated) with snow and ice melt water from higher altitude area, mid-subtropic lakeshore swamp area, mid-subtropic flood land swamp area, and plateau lakeshore swamp area. (See also W89-04689) (Author's abstract)
W89-04693

FORMATION AND DEVELOPMENT OF SWAMP ECOSYSTEM AT THE SANJIANG PLAIN IN CHINA,
Changchun Inst. of Geography (China). Dept. of Swamp.
Y. Yongxing.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu, Finland, 6-8 June 1988. Vol. 1. The Academy of Finland, Helsinki, Finland. 1988. p 24-31, 4 tab, 8 ref.

Descriptors: *Swamps, *Marshes, *China, *Wetlands, *Peat bogs, *Geomorphology, Ecosystems, Marsh plants, Peat, Pollen, Climate, Nutrients, Radioactive dating, Climatic zones.

A preliminary study was made of the formation, development and the swamp forming period of swamp ecosystems in the Sanjiang Plain. The swamps in this area could be divided into two large groups, i.e. peat swamps formed from water bodies, or non-peat, and gley swamps formed from meadows. The peat accumulation in the peat swamps is decided by ecological environment factors (the swamp microbes, micromorphology, and swamp hydrology), biotic factors, and period of formation. The swamps remained at a low entrophic stage of development for a long period. Development was influenced by the regional ecological environment and by the climatic zone in which the swamps were situated. The peat swamps in this area had been formed in the initial stage of the early Holocene period and continued to develop in the middle and the late Holocene period. The forming of gley swamp was later and occurred mostly in the late Holocene period. (See also W89-04689) (Author's abstract)
W89-04694

MIRES IN ALPINE AND COLD REGIONS OF CHINA,
Changchun Inst. of Geography (China).
M. Xuehui, and W. Rongfen.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu, Finland, 6-8 June 1988. Vol. 1. The Academy of Finland, Helsinki, Finland. 1988. p 32-39, 1 fig, 5 tab, 5 ref.

Descriptors: *Mires, *Peat bogs, *Marshes, *China, *Wetlands, *Alpine regions, *Cold regions, *Geomorphology, Marsh plants, Peat, Eutrophication, Mesotrophy, Oligotrophy, Microenvironment.

In alpine and cold regions of China, influenced by regional natural conditions, eutrophic mire is dominant and widely distributed. Eutrophic mire area accounts for 95% of the total mire area of the regions. Oligotrophic mire remains in the early stage of development; its features hydrological and soil features are atypical. Mesotrophic and oligotrophic mires are mainly distributed in the Daxinganling Mountains, the Xiaoxinganling Mountains and some local sites of the Changbai Mountains. Because of the effect of water, freezing and thawing, and biology, different shapes of micro-landforms are formed on the mire surface. These micro-landforms, in turn, influence the hydrological regime, plant growth and development of mires. Mire micro-landforms are classified into 4 types and 12 groups, according to the genesis and shape . (See also W89-04689) (Author's abstract)
W89-04695

WETLAND RESOURCES IN THE UPPER RIVER DERWENT CATCHMENT OF THE SOUTHERN PENNINES OF ENGLAND, WITH PARTICULAR REFERENCE TO SPRINGS, FLUSHES AND SPRING-MIRES,
Leicester Univ. (England). Dept. of Adult Education.
S. E. Page.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu, Finland, 6-8 June 1988. Vol. 1. The Academy of Finland, Helsinki, Finland. 1988. p 40-45, 9 ref.

Descriptors: *Species diversity, *Mires, *Peat bogs, *River basins, *Wetlands, *Peat soils, *England, *Geomorphology, *Springs, Marshes, Geology, Marsh plants, Chemical properties, Conservation.

The catchment of the upper River Derwent (Derwentdale) is an upland area which lies at the southern end of the Pennine Hills in central England. The vegetation is predominantly species-poor grassland on mineral soils or moorland on blanket peat, although there are a few habitats with relatively high species-diversity, including springs, flushes and spring-mires. Limnocrene and rheocrene springs grade into 'flushes' when water spreads out, giving a more diffuse and less rapid flow. The waters of a spring-mire, or helocrene spring, flow away in several ill-defined, slow-flowing channels rather than a single fast-flowing spring brook. These crenitic sites were the subject of a detailed study. The geology of Derwentdale is composed of alternating beds of hard, porous gritstones and less permeable but softer shales. Springlines arise either where the junction of gritstone and shale is exposed on a valley side or where fissures in the gritstone emerge at the land surface. The egressing waters differ both in their hydrology (rheocrenes, limnocrenes and helocrenes are all present) and hydrochemistry (spring-waters which have been in contact with the shale partings have higher pH and enhanced ionic concentrations). This variation is reflected in the range of crenitic plant communities which occur within the catchment. Eight categories were recognized, ranging

from open, bryophyte-dominated rheocrenes to sedge-rich helocrenes. These crenitic sites have a high conservation value as they are examples of relatively natural plant communities unaltered to any great extent by human activities. They also support several locally rare plant species and should be afforded protection from potentially damaging operations so that water supply and quality are maintained. (See also W89-04689) (Author's abstract)
W89-04696

TEMPERATURE CHANGES IN THE SOIL AND CLOSE TO THE GROUND ON WETLANDS DRAINED FOR FORESTRY,
Joensuu Univ. (Finland). Dept. of Biology.
A. Latja, and H. Kurimo.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu, Finland, 6-8 June 1988. Vol. 1. The Academy of Finland, Helsinki, Finland. 1988. p 46-51, 2 fig, 2 tab, 12 ref.

Descriptors: *Forest management, *Environmental effects, *Drainage effects, *Marshes, *Wetlands, *Finland, Air temperature, Soil temperature, Microclimate, Peat, Frost, Environmental effects, Analysis.

The effects of draining of peatlands on temperature conditions in the peat and the air above was examined in two pine mires belonging to small catchment areas of the brooks Valipuro and Suopuro in Sotkamo, eastern Finland. Daily maximum and minimum air temperatures were measured at 0, 5, 50, 200 and 400 centimeters above surface level with mercury thermometers situated in wooden radiation shelters. Peat temperatures were measured at 5, 10, 20, 50 and 75 centimeters below surface level with mercury thermometers inserted in plastic tubes and pushed into the peat to the desired depth. To detect the effects of drainage, the relationships between both peat and air temperatures in the control area (Valipuro) and drained area (Suopuro) were calculated before and after drainage and expressed by means of linear regression equations. No significant changes in soil temperatures were found, however, drainage caused frost to penetrate deeper into the soil and stay longer in the soil in spring. At surface level and five centimeters above, daily extremes in air temperatures became more extreme as a result of draining. The deviation in a more extreme direction was maximally 2 C. The implications of these findings are discussed in relation to the thermal conductivity and energy storage capacity of the peat. (See also W89-04689) (Geiger-PTT)
W89-04697

STREAMFLOW RESPONSE FROM AN OMBROTROPHIC MIRE,
North Central Forest Experiment Station, Grand Rapids, MN. Forestry Sciences Lab.
For primary bibliographic entry see Field 2E.
W89-04698

EFFECT OF DRAINAGE ON THE TEMPERATURE OF SURFACE PEAT,
Joensuu Univ. (Finland). Dept. of Forestry.
H. M. Mannerkoski.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu, Finland, 6-8 June 1988. Vol. 1. The Academy of Finland, Helsinki, Finland. 1988. p 60-65, 2 fig, 2 tab, 12 ref.

Descriptors: *Peat, *Soil temperature, *Drainage effects, *Wetlands, *Peat bogs, *Finland, *Environmental effects, Marshes, Water table fluctuations, Drainage ditches, Soil moisture retention.

The temperature of peat was followed in a ditch spacing, ditch depth, and furrowing experiment on Viheriaisenneva bog in central Finland. Measurements were made with the Pallmann method, based on temperature dependence of sucrose inversion, in the summers of 1972 and 1974 on an area drained in the winter of 1967. The measuring points were at 2 to 4 m intervals on lines crossing at right angles to the ditches. The treatments studied were (ditch spacing/ditch depth): 40 m/100 cm, 25 m/70 cm, 10 m/40 cm, and 10 m/100 cm. The dependence of the effective mean temperature of the peat on the distance from the ditch is clear when the measurements less than 1.5 m from the ditch are ignored. The mean temperature of the peat soil was higher the greater the distance from the ditch or smaller the depth of the ground water table. The mean temperature was minimal at the distance of 1.5 to 3 m, and on the most effectively drained places even 5 m, from the ditch. Near the ditch the mean temperatures were higher again, probably due to the warming effect of the marginal slope of the ditch. It was concluded that drainage had decreased the mean temperature of the peat soil. (See also W89-04689) (Author's abstract)
W89-04699

RELATIONSHIP BETWEEN RAINFALL AND PEAT WATER CHEMISTRY AND THE IMPLICATIONS FOR MANAGEMENT AT CHARTLEY MOSS NATIONAL NATURE RESERVE, ENGLAND,
Nottingham Univ. (England). Dept. of Botany.
J. O. Rieley.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu. Finland, 6-8 June 1988. Vol. 1. The Academy of Finland, Helsinki, Finland. 1988. p 66-71, 3 tab, 11 ref.

Descriptors: *Mires, *Peat bogs, *Marshes, *Chemistry of precipitation, *Vegetation effects, *England, *Rainfall, Peat, Wetlands, Conservation, Correlation analysis, Manganese, Potassium, Magnesium, Ammonia, Nitrates, Nitrogen, Sulfates, Phosphates, Chlorides, Canopy, Throughfall, Forest watersheds.

Changes in water table depth and surface peat water chemistry in the open and under three canopy types were monitored every four weeks on a forested basin mire. These were compared with rainfall data collected at the same time. The water table is highest in the open Sphagnum lawn where the peat forms a floating raft and lowest in marginal areas of consolidated peat. The chemical composition of the precipitation reaching the mire surface is influenced by the vegetation communities. Rainfall in the open has a lower concentration of most ions at every sampling period compared to the throughfall underneath the tree canopies. Correlation analysis reveals little direct influence of precipitation volume on the hydrochemistry of the mire. However, fluctuations in the water table are important in determining the availability of certain ions, in particular potassium, manganese, magnesium, ammonium- and nitrate-nitrogen, sulfate, phosphate and chloride. The implications for the management of this internationally important mire are discussed. (See also W89-04689) (Author's abstract)
W89-04700

ECOLOGICAL FEATURES OF AN ARTIFICIAL WETLANDS AREA,
Vsesoyuznyi Nauchno-Issledovatel'skii Inst. Gidrotekhniki i Melioratsii, Kharkov (USSR).
For primary bibliographic entry see Field 5G.
W89-04701

SNOW MELT AND RUNOFF IN AAPA-MIRE IN FINNISH LAPPLAND,
Helsinki Univ. of Technology, Espoo (Finland). Lab. of Hydrology and Water Resources Engineering.
T. Nisula, and R. Kuittinen.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu, Finland, 6-8 June 1988. Vol. 1. The Academy of Finland, Helsinki, Finland. 1988. p 76-83, 6 fig, 1 ref.

Descriptors: *Snowmelt, *Runoff, *Marshes, *Wetlands, *Finland, Streamflow, Satellite technology, Model studies, Peat bogs, Mathematical models, Simulation analysis, Albedo.

In spring 1987 snowmelt and factors affecting snowmelt were studied in the Pomoaapa Mire in Finnish Lappland. Snowmelt started earlier on the mire and most of the meltwater was stored on the mire until almost all snow in the mire was melted. This caused a rapid increase of runoff in the latter part of the snow melt. During the melting period the mire was covered by snow water and ice, which was frozen in the previous autumn. Reasons for rapid snowmelt and sudden discharge of melt water were determined by field studies, satellite imagery, and runoff modeling. Melt water coming from the surrounding areas to the mire accelerates the wetting of the snow cover on the mire. This wetting by the humus-colored water decreases the albedo of the mire, which increases the melting rate. Peat ridges in its surface structure divide the mire into smaller areas where the water is stored until the end of the snowmelt. Thus the sudden discharge from the mire happens at the end of the snowmelt. The rapid advance of the snowmelt on the mire causes a very significant increase of runoff at the end of snowmelt on the mire in years when the melt period is short. (See also W89-04689) (Author's abstract)
W89-04702

SEASONAL VARIATION IN STREAMFLOW RECESSIONS IN THE MIRE COMPLEX KOMOSSE, SOUTHERN CENTRAL SWEDEN,
Royal Inst. of Tech., Stockholm (Sweden). Institutionen foer Kulturteknik.
C. O. Brandesten.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu. Finland, 6-8 June 1988. Vol. 1. The Academy of Finland, Helsinki, Finland. 1988. p 84-91, 3 fig, 3 tab, 22 ref.

Descriptors: *Mires, *Marshes, *Sweden, *Streamflow, *Runoff, *Wetlands, *Recession, *Peat bogs, Seasonal variation, Catchment areas, Forest watersheds, Vegetation effects, Evapotranspiration, Flow profiles, Transpiration, Glacial drift.

The recession characteristics of eight mire catchments within the Komosse Mire was examined. The catchments (0.26-11.0 sq km) consist mainly of raised bogs generally lacking forest and glacial till with forest. The total mire and forest content range between 31-98% and 1-83%, respectively. Daily runoff data were analyzed for 1972-1976, a period which was drier and warmer than normal. The recession rates increased for virtually all catchments and all flow magnitudes during the growing season (May-September) compared to the dormant season (October-April). In general the increase was smaller for the catchments with high mire percentage and sparse forest cover, compared to those with extensive forest cover. Furthermore the recession rates were found to change with the magnitude of daily runoff, with the minimum around 1/10 of the daily mean. A higher increase in summer recessions for extensively forested catchments indicates that transpiration affects the runoff formation to a greater extent in forested till areas than in treeless bogs. (See also W89-04689) (Author's abstract)
W89-04703

CONTRIBUTIONS TO THE STUDY OF PEATLANDS INFLUENCE ON MAXIMUM FLOW,
Institutul de Meteorologie si Hidrologie, Bucharest (Romania).
For primary bibliographic entry see Field 2E.
W89-04704

BASIS OF THE HYDROLOGICAL BALANCE AND DRAINAGE TECHNIQUE OF BOGS FOR PEAT PRODUCTION,
Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). Poltto- ja Voiteluainelaboratorio.
T. Jarvinen.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu. Finland, 6-8 June 1988. Vol. 1. The Academy of Finland, Helsinki, Finland. 1988. p 148-154, 5 fig, 1 tab, 12 ref.

Descriptors: *Environmental effects, *Peat bogs, *Drainage effects, *Drainage practices, *Peat,

*Hydrologic budget, Drying, Water table, Soil water potential, Models, Finland, Ditches, Decomposition, Hydraulic conductivity.

Peat production is based on the solar drying of peat on the open fields or bogs, which are specially ditched and levelled. The aim of this work is to examine the literature and Finnish experience for basic planning models and figures for improving ditching technology. The theory of water movements in soils is applied to the drainage technique of peat production. Also experience from agriculture and afforestation has been used for the preparation of bogs. The difficulty is the inhomogeneous character of peat due to different biological origin and the degree of decomposition. The basic thing is how to determine the hydraulic conductivity and the water potential using rapid, reliable, economical methods. At the moment it seems possible to solve this question. From the field drying point of view it is evident, that the distance of the water table to the peat field surface should be at least 50 cm or more. The problem is how to bring water tables to the acceptable levels more economically using different types of drainage. This process meeds more precise information for its realization. (See also W89-04689) (Author's abstract)
W89-04710

HYDROLOGICAL RESEARCH IN DISTURBED BOGS AND ITS ROLE IN DECISIONS ON WATER MANAGEMENT IN THE NETHERLANDS,
Agricultural Univ., Wageningen (Netherlands). Dept. of Land and Water Use.
J. M. Schouwenaars.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu, Finland, 6-8 June 1988. Vol. 1. The Academy of Finland, Helsinki, Finland. 1988. p 170-177, 2 fig, 3 tab, 9 ref.

Descriptors: *Peat bogs, *Water management, *The Netherlands, *Water table fluctuations, *Hydrology, *Groundwater management, *Environmental effects, *Wetlands, Peat, Seepage, Simulation analysis, Model studies, Spatial distribution, Site selection, Soil-water-plant relationships, Regeneration, Research priorities.

In disturbed bogs attempts are made to restore the hydrological conditions required for the reestablishment of bog vegetation. A simulation model for groundwater fluctuations is used to evaluate different water management options. Fluctuations are strongly influenced by the hydro-physical properties of the peat relicts. The impact of internal- and external water management measures depend on hydrological conditions such as area and spatial distribution of open water and seepage to the underlying aquifer. It is concluded that hydrological research primarily should focus on the selection of the most suitable sites for restoration. In areas where seepage exceeds 150 mm/yr, buffer zones might be recommended. Detailed models of plant-soil-water relations are only useful when site-specific hydrological characteristics are known. If not, simple models are preferred. Further research on hydrological constraints for bog regeneration is needed to develop criteria for decisions on water management. Some results of field research in the Engbertsdijksvenen area are presented. (See also W89-04689) (Author's abstract)
W89-04713

SEEPAGE COMPONENT IN WATER BALANCE OF PEAT SOILS,
Gdansk Technical Univ. (Poland). Inst. of Hyrdotechnics.
For primary bibliographic entry see Field 2G.
W89-04714

EFFECTS OF CLEAR-CUTTING AND FORESTRY DRAINAGE ON WATER QUALITY IN THE NURMES-STUDY,
North Karelian Water District Office, Joensuu (Finland).
For primary bibliographic entry see Field 4C.
W89-04718

ORGANIC CARBON DYNAMICS IN SMALL BROOKS BEFORE AND AFTER FOREST DRAINAGE AND CLEAR-CUTTING,
Joensuu Univ. (Finland). Karelian Inst.
For primary bibliographic entry see Field 4C.
W89-04719

EFFECTS OF SILVICULTURAL MEASURES ON PRIMARY PRODUCTION IN FOREST BROOKS,
Joensuu Univ. (Finland). Dept. of Biology.
For primary bibliographic entry see Field 4C.
W89-04721

EFFECTS OF HARVESTING ON REGENERATION AND BIOLOGICAL PRODUCTION OF PHRAGMITES AUSTRALIS IN WETLANDS,
Tohoku Univ., Sendai (Japan). Biological Inst.
For primary bibliographic entry see Field 4C.
W89-04722

SHORT-TERM CHANGES IN VEGETATION ON PINE MIRES AFTER DRAINAGE FOR FORESTRY,
Office of Environmental Protection, Kouvola (Finland).
For primary bibliographic entry see Field 4C.
W89-04723

PRELIMINARY RESULTS OF A MOLE DRAINAGE EXPERIMENT IN PIIPSANNEVA PEAT HARVESTING SITE,
Vapo Oy, Jyvaskyla (Finland).
For primary bibliographic entry see Field 4A.
W89-04725

EFFECTS OF PEATLAND FORESTRY MANAGEMENT AND FUEL PEAT MINING IN LAKE ILAJANJARVI, EAST FINLAND: A PALEOLIMNOLOGICAL STUDY,
Joensuu Univ. (Finland). Karelian Inst.
For primary bibliographic entry see Field 4C.
W89-04726

SEDIMENTATION IN LAKE PALOJARVI, NORTHERN KARELIA, THE OLDEST RESERVOIR IN FINLAND,
Joensuu Univ. (Finland). Dept. of Geography.
H. Vesajoki, and H. Simola.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu, Finland, 6-8 June 1988. Vol. 1. The Academy of Finland, Helsinki, Finland. 1988. p 302-307, 3 fig, 11 ref.

Descriptors: *Silting, Lake sediments, *Paleolimnology, *Reservoirs, *Finland, *Sedimentation, Diatoms, Cores, Artificial lakes, sediments, Catchment areas, Heavy metals.

The recent history of Lake Palojarvi was investigated by means of chemical and diatom analyses of short sediment cores. The water-level was raised by some 8 meters in the mid-1950's and the lake was converted from a small forest pool of area 2 sq km, with a drainage basin of 55 sq km into the 8 sq km central basin of a major reservoir system with a catchment area of 6800 sq km. The filling-in period is represented by a massive, dark organic layer at a depth of 10-6 cm covered by a thin, pale minerogenic stripe. The sediment accumulation rate above this marker horizon is of the order of 1.5-2 mm/yr (125 g/sq m/yr on average), corresponding to the accumulation rates observed in younger man-made lakes in Finland. Inflow of water into the basin from the large Lake Koitere is evidenced by the occurrence of certain large-lake diatoms in the sediment from a depth of 8-6 cm upwards, e.g. Melosira islandica. Geochemically, the filling period is indicated by an abrupt increase in heavy metal precipitation (Fe, Zn, Cu, Hg). Since the profound hydrological change, these concentrations have stabilized to a level two or three times higher than the pre-reservoir background values. (See also W89-04689) (Author's abstract)
W89-04728

HUMIC LAKES: ACIDITY FROM NATURAL AND ANTHROPOGENIC SOURCES,
National Board of Waters, Helsinki (Finland).
P. Kortelainen, and J. Mannio.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu, Finland, 6-8 June 1988. Vol. 1. The Academy of Finland, Helsinki, Finland. 1988. p 308-316, 3 fig, 4 tab, 12 ref.

Descriptors: *Water pollution sources, *Limnology, *Acid rain effects, *Peat bogs, *Acidic water, *Lakes, *Finland, Humic acids, Water quality, Hydrogen ion concentration, Sulfates, Organic acids, Regression analysis, Watersheds, Organic matter.

The headwater lakes in peat-rich areas in Finland commonly have high organic matter concentrations and are surrounded by base-poor watershed soils and bedrock. As a result the organic acid load on the watercourses is generally high. The significance of the organic versus anthropogenic acidity in 60 humic, moderately acid lakes (TOC > or = 5 mg/L, pH range 4.3-7.1) was evaluated in areas receiving different levels of acid deposition. The lakes were sampled during autumn overturn, and the water quality of these lakes can be considered to represent rather well the average water quality in small lakes in Finland. The organic matter in the lakes originates mainly from the watershed, while the non-marine sulfate concentrations are chiefly determined by acid deposition. According to the correlation and regression analyses TOC was a better predictor of pH than sulfate. Base cation concentrations were important in determining the sensitivity of the lakes to organic and anthropogenic acidity. The highest minerogenic acid contribution was found in high deposition areas, while the organic acid contribution increased in low deposition areas. The important role of the watershed in determining the pH of the lakes was illustrated by the significant relationships between pH and all the measured watershed parameters. It would appear that the pH of the studied humic lakes is determined to a greater extent by individual watershed characteristics than by their geographical location. (See also W89-04689) (Author's abstract)
W89-04729

INFLUENCE OF DRAINAGE AND DEVELOPMENT OF OVERWETTED LANDS ON QUANTITATIVE AND QUALITATIVE NATURAL WATER INDICES,
Ukrainskii Nauchno-Issledovatel'skii Inst. Gidrotekhniki i Melioratsii, Kiev (USSR).
For primary bibliographic entry see Field 4C.
W89-04730

PROCEEDINGS OF THE INTERNATIONAL SYMPOSIUM ON THE HYDROLOGY OF WETLANDS IN TEMPERATE AND COLD REGIONS.
Joensuu, Finland, 6-8 June 1988. Vol. 2. The Academy of Finland, Helsinki, Finland. 1988. p 105.

Descriptors: *Wetlands, *Peat bogs, *Clear-cutting, *Drainage effects, *Water quality, Runoff, Forestry, Environmental effects, Geomorphology, Conservation, Marshes, Water table fluctuations, Canada, Finland, USSR, United Kingdom, Swamps, Snow cover, Soil water, Ecological effects.

Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions held in Joensuu, Finland, 6-8 June, 1988 are presented under four sections: conservation of wetlands; classification, geomorphology and properties of peatlands; hydrology of wetlands and man's influence on them; and water quality of peatlands and man's influence on them. In the first section the global concern of wetlands conservation is discussed. In the second section, papers on the following topics are presented: properties, geomorphology and classification of peatlands; modern methods to study marsh-ridden areas in West-Siberia; water and energy regime of palsa bogs in West-Siberia; optimization of the microclimate of bog geosystems; alternation of hydrological-ecological linkages in wetland soils with an

example of pedogenic deflection on Exmoor, United Kingdom; and soil moisture-groundwater relation in the floodplain area of the Danube River. In the third section, papers on the following topics are presented: the hydrology of wetlands and man's influence on it; the role of the structure of infraswamp basins for river runoff formation from swamps; drainage effect on the environment; and water table profiles of drained forested and clear-cut peatlands in Northern Ontario, Canada. In the fourth section papers are presented on the following topics: water quality of peatlands and man's influence on it; effect of peat production on water quality and bacterioplankton in the drainage basin of the River Kiiminkijoki; and radiocesium profile and snow cover mass measurements. (See W89-04732 thru W89-04744) (Geiger-PTT)
W89-04731

PROPERTIES, GEOMORPHOLOGY AND CLASSIFICATION OF PEATLANDS,
Exeter Univ. (England). Dept. of Geography.
E. Maltby.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu, Finland, 6-8 June 1988. Vol. 2. The Academy of Finland, Helsinki, Finland. 1988. p 5-13, 2 tab, 30 ref.

Descriptors: *Peat bogs, *Wetlands, *Peat, *Geomorphology, *Ecosystems, Social aspects, Land use, Climate, Geochemistry, Marshes, Biological properties.

There is increasing realization of the ecological and environmental importance of wetlands, a significant proportion of which are peat-forming. The global peatland resource may be at least 500 M ha (3.8% of the world land surface) but is being lost progressively. A reasonable understanding exists of the physical, chemical and biological properties of peat and recent work has produced relatively sophisticated models of peat formation. A wide range of classification systems has been developed based largely on genesis/hydromorphology/geomorphology/vegetation. The most recent work of the Nature Conservancy Council has adopted the rational of functional hydrology based on the work of Ivanov (1981). In this scheme four levels of functional hydrology are identified: mire macrotope, mire mesotope, mire microtope, and mire microform. The mire macrotope develops when mires extend beyond their immediate hydrological systems and combine to form larger units, e.g. blanket bogs, muskeg, taiga mires. They are complex hydrological systems in which stability is dependent on the interaction of component mesotopes and microtopes. The mire mesotope constitutes a body of peat which has developed as a single hydrological entity, e.g raised bog. Each mesotope surface can contain a range of microtopes. A mire microtope refers to the surface features of microforms which are particularly characteristic of ombrotrophic mires, e.g. ridges and pools. The mire microform refers to individual surface features within the patterning of a mire, e.g. hummock or pool. A new approach to assessment and classification of peatlands is advocated based on their functions and social values. This would supplement traditional methods and provide an improved basis for land planning. (See also W89-04731) (Author's abstract)
W89-04732

UP-TO-DATE METHOD TO STUDY MARSH-RIDDEN AREAS IN WEST SIBERIA,
Gosudarstvennyi Gidrologicheskii Inst., Leningrad (USSR). Lab. of Swamp Hydrology.
S. M. Novikov.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu, Finland, 6-8 June 1988. Vol. 2. The Academy of Finland, Helsinki, Finland. 1988. p 14-17, 4 ref.

Descriptors: *Cold regions, *Wetlands, *Siberia, *Marshes, *Swamps, *USSR, *Remote sensing, Networks, Hydrological data collections, Meteorological data collection, Hydrologic budget, Aerial photography, Satellite technology.

The territory of West Siberia is characterized by a high percentage of swamp areas and a great amount of water availability. Cultivation of this territory required the development of an effective method to study the environment, in particular, to investigate the structure and heat-water regime of swamps. The solution of this problem was realized through a geotope approach at the organization of studies for observations of water and heat regime components in every swamp microtope. This approach makes it possible to apply information on the structure and regime of swamps obtained at individual points for hydrometeorological regime characteristics over vast marsh-ridden areas. The practical application of the geotope approach for swamp studies was made on the basis of the rational combination of stationary, field and remote-sensing methods of investigations and computation of water and heat regime components from meteorological data of the base network. (See also W89-04731) (Author's abstract)
W89-04733

WATER AND ENERGY REGIME OF PALSA BOGS IN WEST SIBERIA,
Gosudarstvennyi Gidrologicheskii Inst., Leningrad (USSR). Lab. of Swamp Hydrology.
Y. P. Moskvin.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu, Finland, 6-8 June 1988. Vol. 2. The Academy of Finland, Helsinki, Finland. 1988. p 18-21, 1 fig.

Descriptors: *Cold regions, *Wetlands, *Siberia, *Peat bogs, *Permafrost, *USSR, *Mathematical models, *Hydrologic budget, Project planning, Meteorological data collection, Hydrological data collections, Mapping, Water resources development, Energy, Precipitation, Runoff, Evapotranspiration.

Palsa bogs typical of the permafrost zone occupy vast areas in the industrially developing regions of the northern West Siberia. Scientific recommendations for the economic development of the region are based on the study of the natural conditions and of the underlying surface properties such as water and heat regime of bogs. Based on a 9-year study of palsa bogs a mathematical model has been developed of the water and heat regime of bogs which uses routine meteorological data as input parameters. The use of the model helped to evaluate the long term average and extreme 10-day, monthly and annual values of all water and heat balance components of palsa bogs. Maps of long term average precipitation, evapotranspiration, net radiation and runoff from bogs have been prepared. The results obtained may be useful in project designing. (See also W89-04731) (Author's abstract)
W89-04734

OPTIMIZATION OF THE MICROCLIMATE OF BOG GEOSYSTEMS,
Akademiya Navuk BSSR, Minsk. Faculty of Geography.
P. A. Kovrigo, and V. M. Yatsukhno.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu, Finland, 6-8 June 1988. Vol. 2. The Academy of Finland, Helsinki, Finland. 1988. p 22-29, 1 fig, 6 tab, 8 ref.

Descriptors: *Bogs, *Wetlands, *Peat bogs, *Microclimate, *Organic matter, *Peat, *Land use, Drainage effects, Land reclamation, Cultivation, Ecosystems, Erosion, USSR, Conservation.

Patterns of the geographic propagation of bog geosystems as an element of the biosphere and means of agricultural production, are considered. Quantitative changes of the components and separate elements of the bog geosystem are brought about by drainage reclamation and land use. An important role is attributed to the investigation of microclimatic conditions (hydrothermal regime of the soil and ground air) which have a negative effect on the vegetation of crop plants, promote the organic matter mineralization and lead to peat soil losses. Microclimate optimization methods are proposed to save the life of drained peat bogs. Such methods include the regulation of the water and temperature regime by affecting the aqueous and thermal properties of peat land, the pattern of land use and the tillage system employed. The study of some microclimate optimization methods has revealed their high agricultural efficiency and ability to ensure ecological stability and longevity of drained bog geosystems. (See also W89-04731) (Author's abstract)
W89-04735

ALTERATION OF HYDROLOGICAL-ECOLOGICAL LINKAGES IN WETLAND SOILS: AN EXAMPLE OF PEDOGENIC DEFLECTION ON EXMOOR, U.K.,
Exeter Univ. (England). Dept. of Geography.
E. Maltby.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu, Finland, 6-8 June 1988. Vol. 2. The Academy of Finland, Helsinki, Finland. 1988. p 30-36, 5 fig, 18 ref.

Descriptors: *Soil genesis, *Environmental effects, *Drainage effects, *Wetlands, *Soil types, *United Kingdom, Chemical properties, Biological properties, Physical properties, Soil horizons, Soil properties, Iron, Soil saturation, Land reclamation, Soil profiles, Organic matter, Vegetation.

Hydromorphic soils have special morphological, chemical, physical and biological characteristics which result from a particular water saturation or flooding regime. The soil forming process can be disrupted completely by human intervention. This has occurred on Exmoor as a result of reclamation for improved agriculture. Stagnohumic gley and iron pan stagnopodzols have been transformed resulting in the development of a brown earth type A horizon in less than 130 years. The alteration is characterized in terms of soil structure, iron chemistry, soil water regime, redox behavior, microbiological indices and change in rate of cellulose decomposition. The new profile is more active (biologically) and no longer supports acidophilous moorland vegetation. (See also W89-04731) (Author's abstract)
W89-04736

SOIL MOISTURE - GROUNDWATER RELATION IN THE FLOODPLAIN AREA OF THE DANUBE RIVER,
Vyskumny Ustav Vodohospodarsky, Bratislava (Czechoslovakia).
For primary bibliographic entry see Field 2G.
W89-04737

HYDROLOGY OF WETLANDS AND MAN'S INFLUENCE ON IT,
North Central Forest Experiment Station, Grand Rapids, MN. Forestry Sciences Lab.
E. S. Verry.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu, Finland, 6-8 June 1988. Vol. 2. The Academy of Finland, Helsinki, Finland. 1988. p 41-61, 10 fig, 110 ref.

Descriptors: *Wetlands, *Climate, *Water table fluctuations, *Drainage effects, *Clear-cutting, *Environmental effects, Evapotranspiration, Streamflow, Marshes, Flood plains, Flood damage, Reservoirs, Ecological effects, Groundwater, Runoff rates.

Wetlands form where flat physiography or climate causes slow water movement, and where water is available at the surface of the earth. Water source determines wetland type. The quality, quantity, and periodicity of water at the site drives the ecologic development of wetlands. Climate determines wetland form (Aapa, palsa, raised, etc.), but in both cold and temperate regions, groundwater can substitute for direct precipitation and ameliorate marginal climate. Wetlands evapotranspire at maximum potential rates when the water table is within 30 cm of hollow bottoms, and at a fraction of potential rates when the water table is greater

than 40 cm below the hollow bottoms. Wetlands reduce flood peaks up to 75% compared to rolling topography when they occupy only 20% of the total basin. Streamflow response to tree harvest or growth is a function of whether the growing season water table is above or below the 30-40 cm depth-to-water-table norm prior to harvest. Drainage of wetlands with closed drains (tile or mole drains) will decrease flood peaks as much as 30% more. Drainage of wetlands with open channel ditches will not change, reduce (-30%), or greatly increase (up to +300%) flood peaks depending on the percent of total basin area drained. Significant increases begin when more than 30% of the total basin is drained with open channels. Downstream flood damage must be considered from the regional landscape perspective. This includes increased flood peaks from the conversion of mineral-soil mature forests to young forests (1-15 years old) or agricultural land; the nature of flood plains; amount and changes in reservoir capacity; and the relative amount of open straight channels in relation to close drains and meandering channels. (See also W89-04731) (Author's abstract)
W89-04738

ROLE OF THE STRUCTURE OF INTRASWAMP BASINS FOR RIVER RUNOFF FORMATION FROM SWAMPS,
Leningrad State Univ. (USSR). Faculty of Geography.
K. E. Tvanov, and T. S. Savelieva.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu, Finland, 6-8 June 1988. Vol. 2. The Academy of Finland, Helsinki, Finland. 1988. p 62-65, 3 fig.

Descriptors: *Swamps, *Runoff, *Remote sensing, Climate, Marshes, Catchment areas, Topography, River basins, Aerial photography, Runoff rates, Models, Peat bogs, Overland flow.

A study was made of the space structure of intraswamp basins, formed under the influence of river runoff formation, from data gathered by remote-sensing and the analysis of runoff dependence on the structure of swamps. The theory of hierarchical structure of oligotrophic moors and its deciphering from photographs of different scales and the method of digital description are worked out for intraswamp basins of oligotrophic moor zones. On the basis of interrelations between various geotopic components, important for runoff formation analysis, several types of watersheds are selected. The parameters of the structure, informative for the runoff assessment, have been determined; dependencies have been obtained between mean long-term maximum intraswamp rivers runoff and parameters of basin structures, and its role has been discovered in the runoff formation from swamps. The main reason for observed differences in maximum river runoff from swamps (under the same climatic conditions) is a great variety of geotopy of intraswamp basins. The structure of these basins is the indicator of runoff. (See also W89-04731) (Author's abstract)
W89-04739

DRAINAGE EFFECT ON THE ENVIRONMENT,
Gosudarstvennyi Gidrologicheskii Inst., Leningrad (USSR).
I. A. Shiklomanov, and S. M. Novikov.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu, Finland, 6-8 June 1988. Vol. 2. The Academy of Finland, Helsinki, Finland. 1988. p 66-71, 1 fig, 1 tab, 1 ref.

Descriptors: *Environmental effects, *Drainage effects, *Wetlands, *Land reclamation, *Peat bogs, *Runoff, Models, Water table fluctuations, Swamps, Hydrologic budget, Evaporation, Marshes, Cropland.

Large-scale drainage of wetlands requires careful investigations of drainage effects on the environment in the reclaimed and adjacent areas. Some of the undesirable effects of drainage are reviewed. Overdrainage of lands may cause a lowering of the groundwater table in adjacent terrains. The gradual vanishing of peatlands is attributable to the drainage of wetlands. Small rivers may become shallower when wetlands are drained. If a swamp is drained for agricultural use, the evaporation norm from the majority of crops may exceed the norm from undrained moors by 2-16%. Research on super-moistened mineral lands that are drained shows that the decrease of evaporation after drainage may be as high as 10-20%. The effect of drainage on river runoff depends on the conditions of groundwater recharge of the swamp area, the type of swamp, and its geomorphology. To avoid or to reduce the negative impacts of drainage, it is necessary to study the laws of interrelations between heat and water exchange in the reclaimed areas in various physiography and to develop reliable methods for their inventory for various drainage projects. (See also W89-04731) (Geiger-PTT)
W89-04740

WATER TABLE PROFILES OF DRAINED FORESTED AND CLEARCUT PEATLANDS IN NORTHERN ONTARIO, CANADA,
Great Lakes Forestry Research Centre, Sault Sainte Marie (Ontario).
G. J. Berry, and J. K. Jeglum.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu, Finland, 6-8 June 1988. Vol. 2. The Academy of Finland, Helsinki, Finland. 1988. p 72-79, 5 fig, 1 tab, 14 ref.

Descriptors: *Forest management, *Wetlands, *Peat bogs, *Clear-cutting, *Drainage effects, *Drain spacing, *Canada, Drainage ditches, Vegetation effects, Swamps, Marshes, Forestry, Aerial photography, Water table fluctuations, Fens.

Water table profiles for the period 7 May to 21 October 1987 were examined in forested and clear-cut peatlands subjected to various drainage ditch spacings. Four vegetation types (Operational Groups, OGs) were represented. Depth to water decreased between ditches as ditch spacing increased and as distance from ditch increased. Differences in depth to water between OGs were attributable to differences in ditch spacing, peat depth and depth of fibric layer. Frequency and duration of three depth-to-water classes that represented wet, moist and dry conditions were compared with rooting depth for black spruce. Optimum ditch spacing was regarded as that which provided the most frequent moist conditions, combined with short-duration wet/dry periods. Optimum ditch spacings ranged from less than 30 m (OG14 Poor Treed Fen) to 60 m (OG11). These spacings were considered to be specific to current site conditions, and may not be optimum for an entire rotation period. (See also W89-04731) (Author's abstract)
W89-04741

WATER QUALITY OF PEATLANDS AND MAN'S INFLUENCE ON IT,
Tampere Water and Environmental District (Finland).
For primary bibliographic entry see Field 5B.
W89-04742

EFFECT OF PEAT PRODUCTION ON WATER QUALITY AND BACTERIOPLANKTON IN THE DRAINAGE BASIN OF THE RIVER KIIMINKIJOKI,
Oulu Univ. (Finland). Dept. of Botany.
K. Heikkinen, and A. Visuri.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu, Finland, 6-8 June 1988. Vol. 2. The Academy of Finland, Helsinki, Finland. 1988. p 99-100.

Descriptors: *Environmental effects, *Water pollution sources, *Finland, *Peat bogs, *Water quality, *Bacteria, *Plankton, *Runoff, Nitrogen, Nitrates, Organic matter, Nutrients, River basins, Iron, Phosphorus, Humic acids, Color, Particulate matter, Peat, Water pollution effects, Ecological effects, Water temperature, Drainage effects.

The effects of peat production on water quality and bacterioplankton densities were studied in the drainage basin of the River Kiiminkijoki. The studies also included estimation of organic and nutrient transport and the nature of the humic substances present. Results of water quality studies showed that the runoff water from peat production areas contained higher total nitrogen, nitrate, ammonium nitrogen concentrations, and nitrogen discharge than that flowing from a natural mire. This increased leaching of nitrogen may be connected with the reduction in nitrification resulting from drying of the peat and the absence of any vegetation in the peat production areas to bind the nutrients. The changes in the concentrations and discharge of organic matter, iron and phosphorus as a result of peat drying were similar but less marked. Draining of the mires in the area may increase the discharge of iron-rich, high apparent molecular weight humic substances capable of binding the majority of the total phosphorus in the water. An alteration in the nature of the humic substances being discharged is detectable in the river water in the loading area. Bacterial densities in all these water samples ranged from 940,000 to 8,220,000 cells/ml. Water temperature, pH, dissolved and particulate organic carbon and conductivity explain 54% of the variance in bacterioplankton densities. The densities increase with temperature and conductivity. Increased nitrogen, iron, and phosphorus concentrations and bacterial densities were usually observed in the river downstream of the peat production areas. Although forest drainage projects have probably had long-term hydrological effects on the drainage basin resulting in changes in water quality, specific attention should be paid to the effects of increased nitrogen, iron and particulate organic matter discharged from peat production areas. (See also W89-04731) (Geiger-PTT)
W89-04743

STATEWIDE SURVEY OF AQUATIC ECOSYSTEM CHEMISTRY: 1985,
California State Dept. of Fish and Game, Rancho Cordova. Water Pollution Control Lab.
For primary bibliographic entry see Field 5B.
W89-04833

GREAT LAKES STORM SURGE PLANNING PROGRAM (SSPP),
National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.
For primary bibliographic entry see Field 6A.
W89-04840

STATUS OF IMPORTANT FISHERIES IN GUNTERSVILLE RESERVOIR, 1985,
Tennessee Valley Authority, Chattanooga. Office of Natural Resources.
R. L. Warden, and A. M. Brown.
Available from the National Technical Information Service, Springfield, VA 22161, as DE88-900016. Price codes: A03 in paper copy, A01 in microfiche. Report No. TVA/ONRERD/AWR--87/26, April 1987. 35p, 9 fig, 8 tab, 6 ref.

Descriptors: *Alabama, *Fisheries, *Guntersville Reservoir, Largemouth bass, Sunfish, Crappie, Fish populations, Water pollution effects.

Guntersville Reservoir, Alabama was impounded in 1939 and has consistently produced above average standing stocks of game, forage, and commercial fish species. Investigations were aimed at forming accurate descriptions of certain fisheries and developing specific management plans that will preserve their economic and aesthetic value. Important findings were as follows: (1) At present, there are proportionally fewer numbers of quality size (or larger) largemouth bass in Guntersville Reservoir; (2) Black crappie are providing good fishing at the present time, but a decline of fishermen's success may be noticed if data on numbers being recruited into the population are accurate; (3) The redear sunfish fishery appears to be well balanced and should continue to provide good fishing annually; (4) Channel catfish are in better condition and growing at a rate well above the

average for mainstream impoundments; and (5) A white crappie fishery was not identified because few fish were collected during the survey, but sampling biases may exist. Management recommendations include: (1) Growth of age II through IV largemouth bass should be monitored for several years to determine if the majority are recruiting into larger size categories annually; (2) Determine methods of accurately assessing white and black crappie populations; (3) Publicize above average redear sunfish fishery; and (4) Investigate presence of toxic substances in channel catfish. (Lantz-PTT)
W89-04845

AQUATIC RESOURCES,
For primary bibliographic entry see Field 5C.
W89-04865

IMPACTS OF WATER LEVELS ON BREEDING CANADA GEESE AND METHODS FOR MITIGATION AND MANAGEMENT IN THE SOUTHERN FLATHEAD VALLEY, MONTANA,
Confederated Salish and Kootenai Tribes of the Flathead Reservation, Pablo, MT.
For primary bibliographic entry see Field 6G.
W89-04878

LONG-TERM MONITORING STUDIES IN THE FRESHWATER PORTION OF THE POTOMAC RIVER-THIRD ANNUAL REPORT, MAY 1985-DECEMBER 1985,
Academy of Natural Sciences of Philadelphia, Avondale, PA. Stroud Water Research Center.
R. L. Vannote, and B. W. Sweeney.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-156625. Price codes: A06 in paper copy, A01 in microfiche. Report No. PPRP-MP-59, October 1987. 192p, 26 fig, 16 tab, 3 ref. Maryland Department of Natural Resources Power Plant Siting Program Contract PR85-067-02.

Descriptors: *Data collections, *Monitoring, *Benthic environment, *Potomac River, *Powerplants, Macroinvertebrates, Maryland, Ecosystems, Species diversity, Population density, Electric powerplants.

The report lists and/or summarizes the data collected during the third year (1985) of a long-term study of the benthic macroinvertebrate fauna of the freshwater portion of the Potomac River extending from Dam No. 5 near Williamsport, Maryland downstream to Seneca Pool near Seneca, Maryland. The primary objective of the study was to evaluate long-term trends in the distribution, abundance, and biomass of benthic macroinvertebrates and identify factors controlling the benthic populations, with particular emphasis on factors associated with existing power plant effluents within the study area. These results will be statistically analyzed and interpreted in subsequent reports. (Author's abstract)
W89-04885

SEDIMENTATION IN LAKE TUSCALOOSA, ALABAMA, 1982-86,
Geological Survey, Tuscaloosa, AL. Water Resources Div.
For primary bibliographic entry see Field 2J.
W89-04900

DIGITAL DATA BASE OF LAKES ON THE NORTH SLOPE, ALASKA,
Geological Survey, Anchorage, AK. Water Resources Div.
For primary bibliographic entry see Field 7C.
W89-04922

MIDWEST (U.S.A.) RESERVOIR WATER QUALITY MODIFICATION: I. PARTICULATE PARAMETERS,
Iowa Dept. of Natural Resources, Des Moines.
For primary bibliographic entry see Field 5C.
W89-04974

MIDWEST (U.S.A.) RESERVOIR WATER QUALITY MODIFICATION: II. OXYGEN-DEMANDING PARAMETERS,
Iowa Dept. of Natural Resources, Des Moines.
For primary bibliographic entry see Field 5G.
W89-04975

MIDWEST (U.S.A.) RESERVOIR WATER QUALITY MODIFICATION: III. SOLUBLE NUTRIENTS,
Iowa Dept. of Natural Resources, Des Moines.
For primary bibliographic entry see Field 6G.
W89-04976

CONCENTRATIONS OF TRACE ELEMENTS IN YELLOW PERCH (PERCA FLAVESCENS) FROM SIX ACIDIC LAKES,
Rutgers - The State Univ., New Brunswick, NJ. Center for Coastal and Environmental Studies.
For primary bibliographic entry see Field 5C.
W89-04977

EFFECT OF SEDIMENT PH AND OXIDATION-REDUCTION POTENTIAL ON PCB MINERALIZATION,
Louisiana State Univ., Baton Rouge. Lab. for Wetland Soils and Sediments.
For primary bibliographic entry see Field 5B.
W89-04980

FACTS AND FALLACIES CONCERNING MERCURY UPTAKE BY FISH IN ACID STRESSED LAKES,
Toronto Univ. (Ontario). Inst. for Environmental Studies.
For primary bibliographic entry see Field 5C.
W89-04982

ALKALINITY DESTRUCTION BY SEDIMENT ORGANIC MATTER DISSOLUTION DURING NEUTRALIZATION OF ACIDIFIED LAKES,
Cornell Univ., Ithaca, NY. Dept. of Environmental Engineering.
For primary bibliographic entry see Field 5B.
W89-04987

CHRYSOPHYTE SCALES IN LAKE SEDIMENTS PROVIDE EVIDENCE OF RECENT ACIDIFICATION IN TWO QUEBEC (CANADA) LAKES,
Trent Univ., Peterborough (Ontario). Trent Aquatic Research Centre.
For primary bibliographic entry see Field 5C.
W89-04988

TOTAL CADMIUM CONCENTRATIONS IN THE WATER AND LITTORAL SEDIMENTS OF CENTRAL ONTARIO LAKES,
Guelph Univ. (Ontario). Dept. of Zoology.
For primary bibliographic entry see Field 5B.
W89-04990

SOME FEATURES OF A BLOOM OF OSCILLATORIA RUBESCENS D.C. REGISTERED IN TWO ITALIAN RESERVOIRS,
Istituto Superiore di Sanita, Rome (Italy).
A. Loizzo, N. Sechi, L. Volterra, and A. Contu.
Water, Air, and Soil Pollution WAPLAC, Vol. 38, No. 3-4, p 263-271, April 1988. 3 fig, 2 tab, 8 ref.

Descriptors: *Reservoirs, *Eutrophication, *Italy, *Toxicity, *Water pollution sources, *Oscillatoria, Flora, Cyanophyta, Tissue analysis, Lethal limit, Bacteria, Dystrophic lakes, Microcystis, Aphanizomenon, Anabaena, Epilimnion.

Biological, microbiological, physicochemical and toxicological analyses carried out during a bloom of Oscillatoria rubescens in two Sardinian lakes, starting in January and lasting 7 months, are summarized. The algal species was found to be biotoxins producer. The toxicity was confirmed through laboratory tests. Acute LD50 in mice was about 120 mg per kg body weight i.p. and at the necroscopic examination, animals showed ochraceous dashes on the liver. When subacute p.o. toxicity tests were performed in liver cells swollen, fragmented or twinned nuclei appeared in a dose related manner. During the bloom, the eutrophic lakes exhibited a reduced number of microbial fecal indicators and a rich population of environmental bacterial flora. The particular length of the bloom (7 months) underlines the dystrophic condition of this reservoir system. Potentially toxic cyanophytes such as Microcystis aeruginosa, Aphanizomenon flos-aquae, Anabaena flos-aquae are endemically present in many artificial lakes. However, this is the first documented case of a toxic strain of O. rubescens bloom. The strain reappeared in late spring 1986 with a limited bloom that involved the epilimnic layers only and then in autumn 1986 affecting all the water column as lake waters were circulating. The toxic features were the same observed in the previous bloom thus confirming the colonization of this strain in both lakes. (Miller-PTT)
W89-04995

SUMMER PRIMARY PRODUCTIVITY AND ASSOCIATED DATA FOR FOUR INDIANA RIVERS,
Indiana Dept. of Environmental Management, Indianapolis. Water Quality Surveillance and Standards Branch.
For primary bibliographic entry see Field 5A.
W89-05003

PHOTOCHEMICAL DECOMPOSITION OF CARBAMATE PESTICIDES IN NATURAL WATERS OF NORTHERN GREECE,
Thessaloniki Univ., Salonika (Greece). Environmental Pollution Control Lab.
For primary bibliographic entry see Field 5B.
W89-05014

AMINO ACID UPTAKE BY A NATURAL POPULATION OF OSCILLATORIA RUBESCENS IN RELATION TO UPTAKE BY BACTERIOPLANKTON,
Institut National de la Recherche Agronomique, Thonon-les-Bains (France). Inst. de Limonologie.
M. Feuillade, J. Bohatier, G. Bourdier, P. Dufour, and J. Feuillade.
Archiv fuer Hydrobiologie AHYBA4, Vol. 113, No. 3, p 345-358, September 1988. 6 fig, 4 tab, 39 ref.

Descriptors: *Limnology, *Oscillatoria, *Cyanophyta, *Phytoplankton, *Eutrophic lakes, *Aquatic bacteria, *Amino acids, Electron microscopy, Lakes.

Size fractionation and electron microscopy autoradiography were used to determine if, in the eutrophic Lake Nantua, the dominant species O. rubescens D.C. can compete successfully with bacteria for the free amino acids. Samples were collected at the depth of maximal Oscillatoria population which was lying at 10 m just below the thermocline and were incubated with carbon-14 amino acid mixture at in situ temperature in the dark. The size fractionation process allowed larger fractions to be obtained that were mainly algae in which O. rubescens accounted for 97% of the total algal biovolume; therefore the radioactivity incorporated into these fractions was mostly attributable to Oscillatoria. Electron microscopy autoradiography of ultra-thin sections of O. rubescens demonstrated their intracellular label and confirmed the ability of O. rubescens to utilize amino acids at natural concentrations and to compete with bacteria for this uptake. Amino acid uptake for O. rubescens is neither attributable to adsorption, to attached bacteria on, nor to an experimental artifact related to high substrate concentrations. (Author's abstract)
W89-05023

DETERMINATION OF AMINOPEPTIDASE ACTIVITY IN LAKEWATER BY A SHORT TERM KINETIC ASSAY AND ITS APPLICATION IN TWO LAKES OF DIFFERING EUTROPHICATION,
Rutgers Shellfish Research Lab., Port North

Norris, NJ. Dept. of Oyster Culture.
For primary bibliographic entry see Field 7B.
W89-05024

PREDICTED AND MEASURED ANNUAL PRIMARY PRODUCTION OF PHYTOPLANKTON: EXAMPLES FROM SOME SWEDISH LAKES,
National Swedish Environmental Protection Board, Uppsala (Sweden). Environmental Quality Lab.
A. Tolstoy.
Archiv fuer Hydrobiologie AHYBA4, Vol. 113, No. 3, p 381-404, September 1988. 12 fig, 5 tab, 43 ref.

Descriptors: *Limnology, *Primary productivity, *Lakes, *Aquatic productivity, *Sweden, *Phytoplankton, Radioactive tracers, Optical properties, Phosphorus, Light, Secchi disks, Transparency, Color, Carbon radioisotopes, Lake Vanern, Chlorophyll a.

Annual primary production was measured in three of the large lakes of Sweden, in the brownish-colored Lake Vanern, in the oligotrophic clear-water Lake Vattern and in the two mesotrophic-eutrophic basins Ekoln and Lilla Ullfjarden of Lake Malaren. The measured values were statistically compared to the OECD population of lakes by plotting of values of annual primary production and annual peak chlorophyll-a into OECD graphs. L. Vanern was found to fall outside the confidence limits for annual primary production. Using quotients, the values predicted from the equations based on phosphorus loading or based on annual mean concentration of phosphorus given by OECD (1982) and on values obtained from equations containing aquatic light were compared to measured values. Methodological errors concerning the C(14) technique were also taken into consideration in the comparison. The value predicted from the phosphorus loading equation was 3.5 times higher and predicted from the annual mean concentration of total phosphorus 5.9 times higher than the measured annual primary production for L. Vanern. When the phosphorus loading model was used for Lake Vattern a value 1.7 times higher than the measured value was obtained. When the prediction was based on the annual mean concentration of total phosphorus a higher quotient, namely 2.6, was obtained. This difference between the predicted and the measured value poses the question whether much of the phosphorus was biologically unavailable or if there may be some inhibitory factor from industry also in Lake Vattern. For Ekoln, the predicted annual primary production was 2.6--3.4 times higher than the measured value. Methodological errors such as impurities in the radioactive solutions and experimental exposure for too long a period may have depressed the photosynthesis and caused the values of annual primary production to be too low. (Author's abstract)
W89-05026

ECOLOGICAL SIGNIFICANCE OF BIOTURBATION OF ZOOBENTHOS COMMUNITY IN NITROGEN RELEASE FROM BOTTOM SEDIMENTS IN A SHALLOW EUTROPHIC LAKE,
Niigata Univ. (Japan). Faculty of Education.
H. Fukuhara, and M. Sakamoto.
Archiv fuer Hydrobiologie AHYBA4, Vol. 113, No. 3, p 425-445, September 1988. 5 fig, 9 tab, 55 ref.

Descriptors: *Limnology, *Cycling nutrients, *Japan, *Lakes, *Eutrophic lakes, *Nitrogen compounds, *Nitrogen cycle, *Bottom sediments, *Benthic fauna, Phytoplankton, Midges, Tubificids, Lake Suwa, Nutrients.

Inorganic N release rate from intact sediment core was measured in Lake Suwa, a Japanese eutrophic lake with high biomass of tubificids and chironomids, to evaluate their role in N release. The release rate, ranging from 10.0 to 90.3 mg/sq m/day with high values in June and August, increased exponentially with total biomass of Chironomus plumosus and Limnodrilus spp. The ratios of inorganic N release rate to organic N sedimentation rate varied from 0.5 to 1.0, suggesting the rapid mineralization of organic N deposited on the sediments by the action of microbes and zoobenthos. The released N from sediment corresponded to about half of the mineralized N in the water column. The results suggest the importance of zoobenthos in N release from sediments into lake water and therefore N supply for phytoplankton. The effect on zoobenthos on sediment including acceleration of nutrient release is termed the 'zoobenthos effect'. (Author's abstract)
W89-05027

CHANGES IN THE STRUCTURAL AND FUNCTIONAL COMPONENTS OF THE FISH COMMUNITY OF A SEASONAL RIVER,
Ibadan Univ. (Nigeria). Dept. of Zoology.
A. A. Adebisi.
Archiv fuer Hydrobiologie AHYBA4, Vol. 113, No. 3, p 457-463, September 1988. 1 fig, 2 tab, 17 ref.

Descriptors: *Fish populations, *Rivers, *Seasonal variation, *Species diversity, Floods, Fish migration, Water depth, Upper Ogun River, Nigeria.

The various structural and functional components of the fish community of the Upper Ogun River, a tropical seasonal river, exhibited seasonal variation in their relative abundance and diversity indices. At the outset of floods accompanying high water level, the river's fish community was characterized by increasing relative abundance and diversity of the piscivores. Towards the end of the lotic phase of the river, the omnivorous fishes became increasingly more preponderant and diverse up to the beginning of the lentic phase of the river. As the water level receded, the fish community was characterized by an increased dominance of the herbivores and eventually the intervores. It is inferred that the temporal fish community instability of this undisturbed seasonal river is most probably due to an interplay of periodic changes in their environmental factors and migratory behavior of some fishes. The environmental factors include the fluctuating water depth and the concomitant seasonal flowing and breaking up of the river. (Author's abstract)
W89-05029

ULTRASTRUCTURE AND PHYSICAL CHARACTERISTICS OF A DISTINCTIVE COLLOIDAL IRON PARTICULATE ISOLATED FROM A SMALL EUTROPHIC LAKE,
National Water Research Inst., Burlington (Ontario).
G. G. Leppard, J. Buffle, R. R. de Vitre, and D. Perret.
Archiv fuer Hydrobiologie AHYBA4, Vol. 113, No. 3, p 405-424, September 1988. 11 fig, 3 tab, 29 ref. Swiss National Foundation Project 2.310-0.84.

Descriptors: *Lakes, *Eutrophic lakes, *Colloids, *Iron, *Physicochemical properties, *Phosphorus, *Calcium, *Silicon, *Aluminum, Electron microscopy, Spectroscopy.

An Fe-rich fraction was isolated from a small eutrophic lake and studied on a particle-specific basis by transmission electron microscopy (TEM) in conjunction with energy dispersive spectroscopy. The limnological context from which the Fe-rich fraction was isolated was characterized using a combination of in situ probes and analytical chemistry. An Fe-rich colloidal particulate was identified; three morphotypes occurred, two of which could be described as globular and one of which as near-globular in shape. The size range determined by TEM was 0.05-0.31 microns, with 3/4 falling in the narrow range of 0.05-0.13 microns. The latter range was more representative of the true particle size distribution than a distribution found by filtration alone, which suggested an average particle size >0.45 microns. Among the entire population of these colloids, about 70% contained Fe whereas most of the remaining 30% were rich in either Si or Ca. Amongst the Fe-rich globules, 86.5% were also rich in P and Ca. Some evidence was found to suggest that Fe/P/Ca-rich particles were occasionally associated with either Si or Si/Al; however, the major fraction of these particles contained exclusively Fe, P and Ca. These new findings are presented in the context of the limnological phenomena documented at the site. (Author's abstract)
W89-05030

MICROFLORA AND BACTERIAL ORGANIC ACID PRODUCTION IN THE BOTTOM SEDIMENT OF LAKE BIWA,
Kyoto Univ., Otsu (Japan). Otsu Hydrobiological Station.
H. Maeda, and A. Kawai.
Nippon Suisan Gakkaishi NSVGAF, Vol. 54, No. 8, p 1375-1383, August 1988. 2 fig, 7 tab, 19 ref.

Descriptors: *Aquatic bacteria, *Limnology, *Lake sediments, *Bottom sediments, *Organic acids, *Japan, *Aerobic bacteria, *Anaerobic bacteria, Aeromonas, Vibrio, Clostridium, Mesotrophic lakes, Eutrophic lakes, Sulfides, Lake Biwa.

The microflora of the bottom sediments in the mesotrophic Northern Lake Biwa, Japan, and in the eutrophic Southern Lake were investigated. The organic content in the sediment was higher in the Southern Lake than in the Northern Lake, whereas the redox potential and the concentrations of total sulfides and organic acids indicated that the sediment in the Northern Lake is under more reduced conditions than that in the Southern Lake. In the sediment of the Northern Lake, the facultative anaerobes Aeromonas and Vibrio were predominant, whereas the obligate aerobe Micrococcus was predominant in the Southern Lake. Clostridium was predominant among the obligate anaerobes in both the Northern and Southern Lakes, but the generic composition of the anaerobes did not differ greatly between the two lakes. The number and activity of organic acid producers were larger in the Northern Lake than in the Southern Lake. Many bacteria isolated from the sediment produced acetate, formate, butyrate, propionate, lactate and citrate. In these organic acids, acetate was produced by numerous bacteria. Organic acids were produced by facultative anaerobes rather than by obligate anaerobes. The activity of organic acid production by facultative anaerobes in the Northern Lake did not decrease even at lower temperature. Based on these results, it is considered that facultative anaerobes capable of producing organic acids play a significant role in the accumulation of organic acids in the sediment of the Northern lake. (Author's abstract)
W89-05032

DEPTH VARIATIONS IN THE CHEMISTRY OF OGUTA LAKE IN SOUTHEASTERN NIGERIA,
Port Harcourt Univ. (Nigeria). Dept. of Zoology.
C. S. Nwadiaro.
Hydrobiological Bulletin HYBUD9, Vol. 21, No. 2, p 133-140, December 1987. 7 fig, 15 ref.

Descriptors: *Limnology, *Oguta Lake, *Nigeria, *Water chemistry, *Nutrients, *Lakes, *Chemical properties, *Hydrogen ion concentration, *Salinity, *Alkalinity, Nitrates, Silica, Dissolved oxygen, Phosphorus, Biochemical oxygen demand, Water depth, Seasonal variation.

Monthly changes in the depth profiles of some chemical characteristics were studied for Oguta Lake, the largest natural lake in southeastern Nigeria. The investigations were conducted from May 1982 to April 1983. Hydrogen ion concentration, salinity and alkalinity did not show significant variations with depth. Nitrate-N showed no definite pattern but in February, October and November, distinct metalimnetic nitrate maxima occurred. Silica was approximately homogeneously distributed with slight negative heterograde curve in February and October. Total P levels were relatively lower in the bottom water but the most distinct discontinuity occurred in November when a metalimnetic maximum co-occurred with a nitrate-N maximum. Dissolved oxygen concentration showed a consistent clinograde profile typical of thermally stratified eutrophic waters. Biochemical oxygen demand values followed the dissolved oxygen pattern very closely. (Author's abstract)
W89-05038

SPECIES RICHNESS OF AQUATIC MACROPHYTE COMMUNITIES IN CENTRAL CANADA,
Winnipeg Univ. (Manitoba). Dept. of Biology.
E. Pip.
Hydrobiological Bulletin HYBUD9, Vol. 21, No. 2, p 159-165, December 1987. 3 tab, 25 ref.

Descriptors: *Macrophytes, *Species diversity, *Rivers, *Lakes, *Streams, *Population density, *Ponds, *Chemical properties, Alkalinity, Phosphorus, Dissolved solids, Chlorides, Nitrates, Sulfates, Hydrogen ion concentration, Canada.

Aquatic macrophyte species richness (SR) was examined at 430 sites in the central Canadian region in relation to water body type, bottom substrate and 8 water chemistry parameters. SR was highest in rivers and lakes, intermediate in creeks, and lowest in ponds. The highest values occurred where granite bedrock, highly organic substrates or sand predominated. SR was significantly inversely correlated in the study area as a whole with 7 of the water chemistry parameters; of these, total alkalinity was the most important. However, the relative importance of the respective parameters differed for various water body types. The relationship between SR and P was positive in ponds, but negative for all other water body types. Stepwise multiple regression analysis identified P, total alkalinity and dissolved organic matter as important factors in ponds; sulfate, total alkalinity and chloride in lakes, and sulfate and P in lotic habitats. Log transformations improved the correlations for some variables. However, the water chemistry parameters examined accounted for less than half of the total variability in SR. SR apparently depends on many different factors, including surface area and bottom type, whose relative contributions vary with situation. (Author's abstract)
W89-05039

PLANT BIOMASS AND NUTRIENT LEVELS OF A TROPICAL MACROPHYTE (CYPERUS PAPYRUS L.) RECEIVING DOMESTIC WASTEWATER,
Dar es Salaam Univ. (Tanzania). Dept. of Zoology and Marine Biology.
For primary bibliographic entry see Field 5D.
W89-05040

CHIRONOMIDS AS WATER QUALITY INDICATORS IN THE RIVER MIGNONE (CENTRAL ITALY),
Universita degli Studi 'La Sapienza', Rome (Italy). Dipt. di Biologia Animale e dell 'Uomo.
For primary bibliographic entry see Field 5A.
W89-05044

SCOPE OF MISSION-ORIENTATION IN DUTCH FRESHWATER ECOLOGY,
Amsterdam Univ. (Netherlands). Dept. of Science Dynamics.
For primary bibliographic entry see Field 6G.
W89-05045

THEORETICAL ANALYSIS OF SEEPAGE FLOW OF THE CONFINED GROUNDWATER INTO THE LAKE BOTTOM WITH A GENTLE SLOPE,
Nara Univ. of Education (Japan). Dept. of Earth Science.
For primary bibliographic entry see Field 2F.
W89-05064

STUDIES ON SOME LIMNOLOGICAL VARIABLES IN SUBTROPICAL LAKES OF THE POKHARA VALLEY, NEPAL,
Kyoto Univ., Otsu (Japan). Otsu Hydrobiological Station.
M. Nakanishi, M. M. Watanabe, A. Terashima, Y. Sako, and T. Konda.
Japanese Journal of Limnology RIZAA, Vol. 49, No. 2, p 71-86, April 1988. 7 fig, 5 tab, 29 ref. Ministry of Education, Science and Culture of Japan grants 59041076 and 60043042.

Descriptors: *Nepal, *Limnology, *Lake morphology, *Trophic level, *Seasonal variation, *Limiting nutrients, Eutrophic lakes, Nitrogen, Carbon, Phosphorus, Regression analysis, Phytoplankton, Seston, Species diversity, Nepal.

Some limnological variables were investigated and analyzed in Phewa, Begnas and Rupa Lakes of Nepal in the late-monsoon and dry seasons. From the data on the levels of total nitrogen, total phosphorus, Chlorophyll a, and phytoplankton primary productivity, Phewa Lake seemed to be mesoeutrophic, and Begnas and Rupa Lakes to be eutrophic. The gradient of the regression line of particulate carbon on Chlorophyll a ranged from 42.1 to 71.4 and suggested that phytoplankton in the investigated lakes had a moderately high or high relative growth rate. In comparing the C:N:P ratios of the seston with the Redfield Ratio and other data on phytoplankton chemical ratios, all the lakes appear to be phosphorus-limited. Variation of species diversity of phytoplankton was great between both the seasons in each lake and tended to depend mainly on the share of the predominant species, Microcystis aeruginosa, in total cell number in Phewa and Begnas Lakes, and on that of Tabellaria fenestrata in Rupa Lake. The similarity index of phytoplankton indicated that phytoplankton in Phewa Lake were similar to those in Begnas Lake but not to those in Rupa Lake. (Author's abstract)
W89-05068

INFLUENCE OF PRECIPITATION ON DEVELOPMENT OF THE DENITRIFICATION PROCESS IN LAKE FUKAMI-IKE,
Nagoya Univ. (Japan). Water Research Inst.
H. Terai.
Japanese Journal of Limnology RIZAA, Vol. 49, No. 2, p 87-92, April 1988. 5 fig, 1 tab, 9 ref. Ministry of Education, Science, and Culture Japan grant 61540473.

Descriptors: *Limnology, *Japan, *Denitrification, *Precipitation, *Lakes, *Nitrogen fixing bacteria, Runoff, Bacteria, Lake Fukami-Ike.

Denitrifying activity in Lake Fukami-ike emerged early in April 1986 as well as in 1985. In contrast to 1985, owing to the depletion of nitrate, denitrifying activity in 1986 did not develop after early May, when its mean and maximum value were 0.033 and 0.155 microg-at N/L/day respectively. On the other hand, the denitrifying bacterial population in the lake grew slowly from April (3 cells/ml) to June (19 cells/ml). The maximum population level was only one-fourth of that in 1985. The difference in the development of the denitrification process between 1985 and 1986 is discussed mainly in terms of the supply of nitrate through precipitation and runoff. From analysis of the correlation between precipitation at Anan Observatory and NO3(-) concentration in Lake Fukami-ike, it is concluded that precipitation during late February to early March determined the nitrate level in the vernal circulation period of the lake, and it is suggested that the nitrate level affected the extent of initial development of the denitrification in the lake. Moreover, NO3(-) in the lake was almost completely depleted during the long drought from 20 May to 15 June 1986, and in situ denitrifying activity was also almost completely suppressed. Under these circumstances, the dependence of denitrifying activity on the precipitation was shown by a correlation between maximum denitrifying activity and the amount of the precipitation during the preceding 20 days. (Author's abstract)
W89-05069

PH DEPENDENCE OF PHOSPHATASE ACTIVITY IN FRESHWATER LAKES,
Science Univ. of Tokyo (Japan). Faculty of Pharmaceutical Sciences.
M. Tabata, W. Tachibana, and S. Suzuki.
Japanese Journal of Limnology RIZAA, Vol. 49, No. 2, p 93-98, April 1988. 3 fig, 2 tab, 12 ref.

Descriptors: *Dystrophic lakes, *Cycling nutrients, *Acidity, *Hydrogen ion concentration, *Lakes, *Plankton, *Enzymes, Alkalinity, Trophic Levels, Japan, Limnology, Phosphatase, Gel chromatography.

The pH dependence of phosphatase activity in lake water was investigated in eight Japanese lakes. Lakes Akanuma, Rurinuma, and Bisyamonnuma were classified as acidotrophic and were high in SO4(-2) and Cl(-). Lakes Shibuike, Nagaike, and Ichinuma were classified as dystrophic and containing much total organic carbon (TOC), while Lakes Shinseiko and Ashinoko were both regarded as harmonic lakes. The phosphatase activities of Lakes Akanuma (pH 3.9), Rurinuma (pH 4.5), Shibuike (pH 4.5) and Nagaike (ph 5.6) were high under acidic conditions (pH 5-6), but low under alkaline conditions (>pH 8). The enzyme activity of Lake Bisyamonnuma (pH 5.7) was high under alkaline conditions, while that of Lakes Ichinuma (pH 6.2), Shinseiko (pH 7.3) and Ashinoko (pH 7.3) was high under both acidic and alkaline conditions. Thus the phosphatase activity of these lakes was closely related to pH rather than components dissolved in the water. The phosphatase collected in the water and that in homogenates of plankton from Lakes Shibuike and Shinseiko were fractionated by gel chromatography. Several phosphatases with various molecular weights (50,000-270,000) were observed under acidic conditions in a plankton homogenate from Lake Shibuike. The molecular weight of the main dissolved phosphatase was 180,000. In a water sample from Lake Shinseiko the molecular weight of the main soluble phosphatase with activity under alkaline conditions was 180,000. This value corresponded to the molecular weight of the main phosphatase in the homogenate of plankton collected from the lake. (Author's abstract)
W89-05070

COMPOSITION AND ABUNDANCE OF ZOOBENTHOS IN THE PROFUNDAL ZONE OF LAKE OZE-NUMA IN CENTRAL JAPAN,
Tamamura Senior High School, Gunma (Japan).
A. Ohtaka, A. Ujiiye, and S. F. Mawatari.
Japanese Journal of Limnology RIZAA, Vol. 49, No. 2, p 109-117, April 1988. 8 fig, 3 tab, 23 ref.

Descriptors: *Limnoloyg, *Benthos, *Benthic fauna, *Species diversity, Biological oxygen demand, Japan, Lakes, Lake morphology.

Composition and abundance of zoobenthos in the profundal zone of Lake Oze-numa were studied at two sites, Lake Center and Off Nushiri, from May to September 1986. Among the eight taxa recorded, three species (Tubifex sp., Limnodrilus hoffmeisteri, and Chironomus sp.) accounted for more than 95.5% of the macrobenthos in number. Species diversity, density, and biomass of macrobenthos were lower at Lake Center (8.8 meters deep in average) than those of Off Nushiri (6.8 meters). Oxygen content was probably an important factor in these differences between the sites. At Off Nushiri, Tubifex sp. and L. hoffmeisteri reproduced throughout the study period but with low proportions; pupae of Chironomus sp. were found only in late June. (Author's abstract)
W89-05072

ISOTOPIC CHARACTERIZATION OF LAKE KIZAKI AND LAKE SUWA,
Mitsubishi-Kasei Inst. of Life Sciences, Tokyo (Japan). Lab. of Biogeochemistry and Sociogeochemistry.
For primary bibliographic entry see Field 2J.
W89-05073

OPTICAL PROPERTIES OF A TURBID RESERVOIR AND ITS PHYTOPLANKTON IN RELATION TO PHOTOSYNTHESIS AND GROWTH (MOUNT BOLD RESERVOIR, SOUTH AUSTRALIA),
Murray-Darling Freshwater Research Centre, Albury (Australia).
R. L. Oliver, and G. G. Ganf.
Journal of Plankton Research JPLRD9, Vol. 10, No. 6, p 1155-1177, 1988. 10 fig, 3 tab, 49 ref.

Descriptors: *Optical properties, *Reservoirs, *Photosynthesis, *Phytoplankton, *Euphotic zone, Irradiation, Light penetration, Seasonal variation, Dynamics, Growth rates, Australia, Vertical distribution, Cyanophyta, Chlorophyll a, Turbidity.

In situ light measurements were made in a turbid Australian reservoir and were used to obtain information on inherent and apparent optical properties. The average vertical attenuation coefficient varied from 1.1 to 4.6 ln units/m. During three periods the variation in the average vertical attenuation coefficient correlated with changes in Chlorophyll a (Chl a) concentration and specific attenuation coefficients of 0.013, 0.014 and 0.022 sq m/mg Chl a were calculated. Chlorophyll-specific diffuse absorption coefficients for these periods were 0.012, 0.013 and 0.017 sq m/mg Chl a and only varied significantly from estimates of the specific attenuation coefficient in the period when scattering was intense. Absorption coefficients and scattering coefficients calculated for the mid-point of the euphotic zone ranged between 0.45 and 2.9/m and 3.5-52.0/m respectively. Chlorophyll-specific absorption coefficients of 0.005, 0.006 and 0.007 sq m/mg Chl a and scattering coefficients of 0.05, 0.09 and 0.191 sq m/mg Chl a were measured during the three periods. The high scattering coefficient value occurred when gas-vacuolate cyanobacteria were dominant. Algal photosynthesis and light absorption were related through the maximum quantum yield which varied between 0.019 and 0.11 mol C/Einstein while average quantum yields varied between 0.006 and 0.024 with a mean of 0.013 mol C/Einstein. A comparison of changes in the mean irradiance of the mixed zone and chlorophyll concentration indicated that growth was light-limited below 0.04-0.05 Einsteins absorbed /mg Chl a/day. (Author's abstract)
W89-05074

DYNAMICS OF AUTOTROPHIC PICOPLANKTON IN LAKE CONSTANCE,
Konstanz Univ. (Germany, F.R.). Limnological Inst.
T. Weiss.
Journal of Plankton Research JPLRD9, Vol. 10, No. 6, p 1179-1188, 1988. 5 fig, 30 ref.

Descriptors: *Population dynamics, *Limnology, *Seasonal variations, *Growth rates, *Plankton, *Lakes, Biomass, Microscopic analysis, Protozoa, Flagellates, Rotifers, Vertical distribution, West Germany, Cyanophyta.

The vertical distribution, biomass concentrations and growth rates of autotrophic picoplankton (APP) were investigated during the growing season (March-October) in Lake Constance at different depths. Cell numbers determined by epifluorescence microscopy varied between 1000 and 160,000 cells/ml depending on season and water depth. Highest concentrations were recorded above the thermocline in late summer. Numerically, APP consisted almost exclusively of chroococcoid cyanobacteria. During lake stratification several peaks of biomass concentrations occurred in epilimnetic waters at intervals of 6-8 weeks. In-situ experiments using a dilution technique and dialysis bags revealed that during summer APP population dynamics were primarily driven by combined changes of their growth and grazing rates, whereas temperature is less important. Gross growth rates varied between 0.006 and 0.051/hour, grazing rates between 0.002 and 0.053/hour. On average APP production was completely removed by grazing within the microbial community. Ciliates, heterotrophic nanoflagellates and rotifers have been identified as the major consumers of APP cells. APP biomass is small compared to larger phytoplankton, ranging from 1 to 5% of total phytoplankton biovolume. Due to its high gross growth rates, which are on the same level as those of free-living pelagic bacteria, APP contributes slightly more to overall primary production with maximum percentages of approximately 15% in late summer. (Author's abstract)
W89-05075

SEASONAL SUCCESSION AND STRATEGIES OF PHYTOPLANKTON DEVELOPMENT IN TWO LAKES OF DIFFERENT TROPHIC STATES,
Clermont-Ferrand-2 Univ., Aubiere (France). Lab. de Zoologie.
C. Amblard.
Journal of Plankton Research JPLRD9, Vol. 10, No. 6, p 1189-1208, 1988. 8 fig, 5 tab, 47 ref.

Descriptors: *Limnoloyg, *Seasonal variation, *Species diversity, *Phytoplankton, *Growth kinetics, *Trophic level, Lake morphometry, Eutrophic lakes, Oligotrophic lakes, Mesotrophic lakes, Succession, Metabolism, France.

Strategies of development adopted by species during succession is related to the metabolism and structure of phytoplankton communities during seasonal periodicity. Two trophically different lakes each demonstrate a different degree of the ecological succession, which prescribes an increasingly complex taxocenose. In oligomesotrophic Lake Pavin the autogenic succession lasts from spring overturn until mid-summer. In eutrophic Lake Aydat the autogenic succession is strictly limited to spring. The seasonal changes of the community productivity, turnover rate and adenylate energy charge confirm the hypothesis of a change of the 'metabolic orientation' of phytoplankton cells during seasonal succession. The autogenic succession represents the progression from a growth-oriented strategy to an equilibrium-oriented one. (Author's abstract)
W89-05076

PRIMARY PRODUCTION IN LAKES HURON AND MICHIGAN: IN VITRO AND IN SITU COMPARISONS,
National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.
G. L. Fahnenstiel, and H. J. Carrick.
Journal of Plankton Research JPLRD9, Vol. 10, No. 6, p 1273-1283, 1988. 3 tab, 44 ref.

Descriptors: *Great Lakes, *Limnology, *Primary productivity, *Lakes, *Incubation, Air-water interfaces, Water depth, Oxygen, Carbon radioisotopes, Photosynthesis, Chlorophyll, Lake Huron, Lake Michigan, Great Lakes, Comparison studies, In situ tests.

Oxygen- and carbon-14-based primary production estimates from 9-16 hours in vitro incubations were compared in lakes Huron and Michigan. For surface mixing layer comparisons, gross O2/C-14 photosynthetic quotients (gross PQ) averaged 2.2, and net O2/C-14 photosynthetic quotients (net PQ) averaged 1.4. The mean gross PQ is consistent with a theoretical PQ based on the CO2 and NO3 assimilation ratio. However, within the deep chlorophyll layer, gross PQ and net PQ averaged 4.9 and 2.8 respectively. These higher values were likely due to excess NO3 reduction at the expense of CO2 uptake. Thus, during short experiments under low light conditions, oxygen evolution and CO2 uptake may not be tightly coupled. In vitro and in situ O2-based production estimates were compared in four diurnal (dawn to dusk) experiments in Lake Huron. In situ production estimates were determined by measuring water-mass oxygen changes and oxygen transfer across the air-water interface. In situ production estimates were approximately twice in vitro production estimates for both surface mixing layer and deep chlorophyll layer comparisons. The difference between estimates was attributable to containment effects manifest in 13-16 h bottle incubations. Short-term (1-2 h) in vitro production was also compared to diurnal in vitro production. Rates of short-term production were approximately 1.6 times higher than rates of diurnal production, suggesting that short-term in vitro production experiments may provide reasonable estimates of in situ primary production. (Author's abstract)
W89-05077

DIFFERENTIAL UPTAKE OF ORTHOPHOSPHATE AND ORGANIC PHOSPHORUS SUBSTRATES BY BACTERIA AND ALGAE IN LAKE KINNERET,
Kinneret Limnological Lab., Tiberias (Israel).
T. Berman.
Journal of Plankton Research JPLRD9, Vol. 10, No. 6, p 1239-1249, 1988. 7 tab, 39 ref. Israel National Council for Research and Development Grant WT-12.

Descriptors: *Absorption, *Essential nutrients, *Phosphorus compounds, *Phytoplankton, *Orthophosphates, *Microbiological studies, Bacteria, Algae, Aquatic environment, Lakes, Enzymes, Israel.

The availability of six organic phosphorus substrates (OPS) to serve as sources of this nutrient for natural populations of phytoplanktonic algae and bacteria was tested by measuring the degree to which the organic substrates decreased uptake of orthophosphate. When added to samples of Lake Kinneret water, six organophosphorus compounds usually lowered the amount of orthophosphate taken up by microplankton retained on 0.2-microm filters. In contrast, OPS addition generally stimulated orthophosphate uptake into the mainly algal fraction (>3 microm), indicating that the bacteria were mostly responsible for utilizing OPS. The sparing effect of OPS addition on orthophosphate uptake was very fast, suggesting that the microorganisms possessed constitutive or rapidly induced enzyme systems to exploit the OPS. The results of this study indicate that a significant flux of phosphorus may pass via dissolved organic phosphorus into microbiota, especially bacteria, in some aquatic systems. (Author's abstract)
W89-05078

ABUNDANCE AND DISTRIBUTION OF BACTERIOPLANKTON IN THE GAMBIA RIVER, WEST AFRICA,
Michigan Univ., Ann Arbor. Great Lakes Research Div.
For primary bibliographic entry see Field 2E.
W89-05079

AVAILABILITY OF DISSOLVED ORGANIC CARBON FOR PLANKTONIC BACTERIA IN OLIGOTROPHIC LAKES OF DIFFERING HUMIC CONTENT,
Lund Univ. (Sweden). Inst. of Ecology.
L. J. Tranvik.
Microbial Ecology MCBEBU, Vol. 16, No. 3, p 311-322, 1988. 4 fig, 3 tab, 42 ref.

Descriptors: *Humic acids, *Limnology, *Oligotrophic lakes, *Dissolved solids, *Bacteria, *Organic carbon, *Variation coefficient, Growth kinetics, Biomass, Plankton.

Bacterioplankton from 10 oligotrophic lakes, representing a gradient from clearwater to polyhumic, were grown in dilution cultures of sterile filtered lakewater. The bacterial biomass achieved in the stationary phase of the dilution cultures was positively correlated with the amount of both humic matter and dissolved organic carbon (DOC) in the lakes. About the same fraction of the DOC pool was consumed in the dilution cultures of all lakes (average 9.5%, coefficient of variation 24%), with approximately the same growth efficiency (average 26%, coefficient of variation 28%). Thus, humic lakes could support a higher bacterial biomass than clearwater lakes due to their larger DOC pools. The relevance of the results to planktonic food webs of humic and clearwater lakes is discussed. (Author's abstract)
W89-05080

EFFECTS OF TEMPERATURE ON MICROBIAL UTILIZATION OF LIGNOCELLULOSIC DETRITUS IN A THERMALLY IMPACTED SYSTEM,
Texas Univ. at Austin, Port Aransas. Marine Science Inst.
For primary bibliographic entry see Field 5C.
W89-05081

PHYSICAL, CHEMICAL, AND BIOLOGICAL CHARACTERISTICS OF THE TURKEY LAKES WATERSHED, CENTRAL ONTARIO, CANADA,
Canada Centre for Inland Waters, Burlington (Ontario).
For primary bibliographic entry see Field 5B.
W89-05082

DETAILED ANALYSIS OF SULPHATE AND NITRATE ATMOSPHERIC DEPOSITION ESTIMATES AT THE TURKEY LAKES WATERSHED,
Atmospheric Environment Service, Downsview (Ontario).
For primary bibliographic entry see Field 5B.
W89-05083

COMPARISON OF BULK, WET-ONLY, AND WET-PLUS-DRY DEPOSITION MEASUREMENTS AT THE TURKEY LAKES WATERSHED,
Atmospheric Environment Service, Downsview (Ontario).
For primary bibliographic entry see Field 5B.
W89-05084

ION MASS BUDGETS FOR LAKES IN THE TURKEY LAKES WATERSHED, JUNE 1981-MAY 1983,
National Water Research Inst., Burlington (Ontario).
For primary bibliographic entry see Field 5B.
W89-05086

ZOOBENTHIC DISTRIBUTION AND BIOMASS IN THE TURKEY LAKES,
Department of Fisheries and Oceans, Burlington (Ontario). Great Lakes Lab. for Fisheries and Aquatic Sciences.
R. M. Dermott.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 45, Suppl. 1, p 107-114, 1988. 1 fig, 4 tab, 38 ref.

Descriptors: *Acid rain effects, *Canada, *Limnology, *Oxygen deficit, *Benthic fauna, *Biomass, *Ecological distribution, *Lake morphometry, *Lake basins, Watersheds, Oligotrophic lakes, Hypolimnion, Aquatic productivity, Biological oxygen demand, Littoral zones, Fish populations, Aquatic insects, Algae, Amphipods, Ontario.

The composition of the benthic fauna in the four oligotrophic lakes of the Turkey Lakes Watershed in Ontario was dependent on the absence of fish, depth, and hypolimnetic oxygen concentrations, rather than the chemical gradient in the watershed. Biomass in the littoral zone was greatest in the fishless upper lake of the watershed (0.35 g/sq m), domirated by amphipods and predatory insects, which replaced fish as top predators in the lake. The shallowest lake (Wishart) had the lowest lakewide biomass (199 g/hectare) and estimated production of the four lakes, in spite of having the greatest algal and fish production in the watershed. The biomass present below 2 meters was greater in the lower two lakes, dominated by the Chironomidae. Little Turkey Lake had the greatest area weighted lakewide biomass (843 g/hectare) and estimated production, as a result of a large population of Chironomus spp. in the hypolimnion. Batchawana Lake, the upper lake in the watershed, had the lowest benthic populations due to severe oxygen depletion in the hypolimnion. (See W89-05082 thru W89-05092 and W89-05094 thru W89-05101) (Author's abstract)
W89-05093

FISH COMMUNITY STRUCTURE, BIOMASS, AND PRODUCTION IN THE TURKEY LAKES WATERSHED, ONTARIO,
Great Lakes Forestry Research Centre, Sault Sainte Marie (Ontario).
For primary bibliographic entry see Field 5C.
W89-05094

YOUNG-OF-THE-YEAR FISH COMMUNITY IN NINE LAKES, VARYING IN PH, ON THE CANADIAN SHIELD,
Great Lakes Forestry Research Centre, Sault Sainte Marie (Ontario).
For primary bibliographic entry see Field 5C.
W89-05095

RISK TO SALMONIDS OF WATER QUALITY IN THE TURKEY LAKES WATERSHED AS DETERMINED BY BIOASSAY,
Lake Superior Research Station, Sault Sainte Marie (Ontario).
For primary bibliographic entry see Field 5C.
W89-05096

FOSSIL MIDGE ASSOCIATIONS IN RELATION TO TROPHIC AND ACIDIC STATE OF THE TURKEY LAKES,
Department of Fisheries and Oceans, Owen Sound (Ontario). Great Lakes Fisheries Research Branch.
For primary bibliographic entry see Field 5C.
W89-05097

SEDIMENT PH IN PROFUNDAL CORE SAMPLES FROM THE TURKEY LAKES (ALGOMA, ONTARIO),
Laurentian Univ., Sudbury (Ontario). Dept. of Biology.
For primary bibliographic entry see Field 5B.
W89-05099

LOADINGS OF ORGANOCHLORINE CONTAMINANTS AND TRACE ELEMENTS TO TWO ONTARIO LAKE SYSTEMS AND THEIR CONCENTRATIONS IN FISH,
Department of Fisheries and Oceans, Burlington (Ontario).
For primary bibliographic entry see Field 5B.
W89-05101

BLOOD OXYGEN CAPACITY DIFFERENCES IN YELLOW PERCH (PERCA FLAVESCENS) FROM NORTHERN WISCONSIN LAKES DIFFERING IN PH,
Wisconsin Univ.-Madison. Center for Limnology.
For primary bibliographic entry see Field 5C.
W89-05102

MULTIVARIATE ANALYSIS OF CORRELATIONS BETWEEN ENVIRONMENTAL PARAMETERS AND CADMIUM CONCENTRATIONS IN HYALELLA AZTECA (CRUSTACEA: AMPHIPODA) FROM CENTRAL ONTARIO LAKES,
Guelph Univ. (Ontario). Dept. of Zoology.
For primary bibliographic entry see Field 5B.
W89-05103

ACCUMULATION OF MERCURY BY PLANKTON AND BENTHIC INVERTEBRATES IN RIVERINE LAKES OF NORTHERN MANITOBA (CANADA): IMPORTANCE OF REGIONALLY AND SEASONALLY VARYING ENVIRONMENTAL FACTORS,
National Hydrology Research Inst., Saskatoon (Saskatchewan).
For primary bibliographic entry see Field 5B.
W89-05104

DRAINAGE HYDROLOGY IN THE MARSHLANDS OF WESTERN FRANCE,
Centre National du Machinisme Agricole, du Genie Rural, des Eaux et des Forets, Cestas Principal (France). Div. Hydraulique Agricole.
For primary bibliographic entry see Field 4B.
W89-05124

HYDROLOGY OF NATURAL WETLANDS AND WET NATURE RESERVES,
Agricultural Univ., Wageningen (Netherlands). Dept. of Land and Water Use.
W. H. van der Molen.
Agricultural Water Management AWMADF, Vol. 14, No. 1-4, p 357-364, August 1988. 6 ref.

Descriptors: *Hydrology, *Wetlands, *Ecosystems, *Ecological effects, *Reviews, Salt marshes, Swamps, Marshes, Hydrologic systems, Bogs.

This review considers wetlands as they occur in nature, first discussing common properties, and then distinguishing different varieties. Wetlands discussed lack extensive open water spaces or large areas of bare sands and mudflats, and are mostly vegetated. The water logged wetland environment severely limits the number of plant species. Other factors, like high salinity, abundant or very poor supply of plant nutrients, may further reduce the possibilities. Often the vegetation is dominated by only a few but highly typical species. The following main types of wetlands are considered: swamp forests; reedlands and wet grasslands; highmoor bogs; and salt marshes. The general features of wetlands, and their botanical and zoological aspects have been extensively studied. The knowledge about the hydrology of wetlands, however, is scanty. More studies have been made on the hydrology of nature reserves. Interest in wetland hydrology is obviously rising as such areas become scarcer. Our present knowledge of the hydrology of wetlands is insufficient as a base to make the right decisions on how to preserve threatened wetlands. (Author's abstract)
W89-05141

HYDROCHEMISTRY OF RICH FEN AND WATER MANAGEMENT,
Institute for Land and Water Management Research, Wageningen (Netherlands).
R. H. Kemmers, and P. C. Jansen.
Agricultural Water Management AWMADF, Vol. 14, No. 1-4, p 399-412, August 1988. 6 fig, 4 tab, 22 ref.

Descriptors: *Geochemistry, *Water chemistry, *Fens, *Water management, *Geohydrology, *Wetlands, *The Netherlands, Groundwater levels, Aquifer characteristics, Chemical properties, Calcium, Bicarbonates, Hydrologic models, Water quality management.

Rich fen, a type of wetland characterized by calciphyte species, is strictly related to high groundwater levels with high contents of calcium and bicarbonate ions in the soil water. Rich fen is threatened by changes in the water management of surrounding areas. With a view to preserve suitable conditions for rich fen conservation by water management, hydrochemistry of a small rich fen was studied in relation to its hydrology. In order to know whether high groundwater levels are maintained by impeded drainage or seepage of groundwater from the aquifer, water balances have been calculated. Chemical balances have been made to decide whether calcium bicarbonate ions originate from local on-site sources or from weathering processes in the aquifer and subsequent seepage to the fen. Vegetation development of rich fen appeared to be conditioned by upward seepage of groundwater having a low redox status and containing high contents of calcium and bicarbonate ions. Rich fen is capable of retaining calcium ions in its topsoil only if the redox status can be maintained on a level that prevents pyrite oxidation. Conservation of rich fen must include regional water management to prevent hydraulic heads in the aquifer to fail to such a level that no seepage can take place. Local water management should be directed to decrease drainage in combination with stimulating surface runoff. (Author's abstract)
W89-05145

IMPACT OF WATER MANAGEMENT UPON GROUNDWATER FLUCTUATIONS IN A DISTURBED BOG RELICT,
Agricultural Univ., Wageningen (Netherlands). Dept. of Land and Water Use.
For primary bibliographic entry see Field 4A.
W89-05148

INTEGRATION OF WETLANDS INTO MAN-MADE LANDSCAPES OF N.W. GERMANY,
Niedersaechsisches Landesamt fuer Bodenforschung, Bremen (Germany, F.R.). Bodentechnologisches Inst.
J. Blankenburg, and H. Kuntze.
Agricultural Water Management AWMADF, Vol. 14, No. 1-4, p 451-458, August 1988. 1 fig, 5 tab, 13 ref.

Descriptors: *Wetlands, *Bogs, *Regeneration, *Perched water table, Landscaping, Ground water levels, Water level fluctuations, West Germany.

An overview is given to the state of highmoor regeneration in Lower Saxony, Federal Republic of Germany. Actions of rewetting and/or maintenance were taken in about 70 bogs. Among these, there are six field trials, which have been investigated since 1974 by the Soil Technology Institute in Bremen to their peat qualities, hydrology and vegetation. In 1985 the amplitude of the perched water table in some of these reserves was less than 0.18 m. The results of the ecological succession in the Lichtenmoor show that such small amplitudes create favorable conditions for further regeneration. Rewetted raised bogs should be separated from agricultural and forest areas by buffer zones and integrated into man-made semi-natural landscape. The minimum size of a rewetted area and its surrounding protection zones cannot be given yet. Furthermore there is need of more research work to determine seepage and evapotranspiration of rewetted bog areas. (Author's abstract)
W89-05149

HYDROLOGY OF THE WETLAND NAARDERMEER: INFLUENCE OF THE SURROUNDING AREA AND IMPACT ON VEGETATION,
Utrecht Rijksuniversiteit (Netherlands). Dept. of Environmental Studies.
P. P. Schot, A. Barendregt, and M. J. Wassen.
Agricultural Water Management AWMADF, Vol. 14, No. 1-4, p 459-470, August 1988. 5 fig, 1 tab, 10 ref.

Descriptors: *Hydrology, *Wetlands, *The Netherlands, *Vegetation effects, *Polders, *Water table decline, Conservation, Drainage effects, Infiltration, Calcium, Bicarbonates, Water quality.

The Naardermeer is a polder located in the central Netherlands at the foot of a sandy ice-pushed ridge. It has been put on the list of internationally important wetlands. During the last decades the water levels in the Naardermeer have become steadily lower due to increasing groundwater extractions in the hill ridge and lowering of the water levels in the adjacent polders. In 1985 a survey was started to establish the relation between hydrology and the occurrence of plant species in the Naardermeer. The hydrological data shows that water quantity and quality in the Naardermeer are strongly influenced by the surrounding area. In the area a clear relationship exists between the pattern of hydrological attributes and the vegetation pattern in reed marshes. Vegetations related to the quality of rain water occur in a random pattern in the Naardermeer. Vegetations related to water rich in calcium and bicarbonate occur in the seepage area where they are supplied directly by groundwater of the calcium-bicarbonate type. This study illustrates the importance of hydrological information for the conservation of nature in wetlands. The impact of both internal and external (upstream and even downstream) processes has to be considered. (Author's abstract)
W89-05150

RESTORATION OF THE VECHT LAKES ECOSYSTEMS SURROUNDING THE HORSTERMEER POLDER: A FEASIBILITY STUDY,
Witteveen and Bos, Deventer (Netherlands).
For primary bibliographic entry see Field 4A.
W89-05151

LAKES. 6. SOUTH AMERICA: SIZE-FRACTIONATED UPTAKE AND REGENERATION OF AMMONIUM AND PHOSPHATE IN A TROPICAL LAKE,
Maryland Univ., Cambridge. Horn Point Environmental Labs.
T. R. Fisher, R. D. Doyle, and E. R. Peele.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IVTLAP, Vol. 23, No. 2, p 637-641, August 1988. 2 fig, 2 tab, 10 ref. NSF grant BSR85-07494.

Descriptors: *Limnology, *Tropical lakes, *Cycling nutrients, *Plankton, *Lakes, *Aquatic productivity, *Ammonium, *Phosphate, Nitrogen, Lake Calado, Phytoplankton, Heterotrophic bacteria.

The cycling of nitrogen and phosphorus within the plankton is a basic process in aquatic systems which determines their fertility and productivity. Measured directly with isotopes, the uptake and regeneration of ammonium and phosphate are community properties, but little is known of the organisms responsible for the computed rates. Phytoplankton, as primary producer, must consume at least some of the ammonium and phosphate, the role of heterotrophic immobilization by bacteria or other organisms is not generally known. Even less is known of the organisms which regenerate nitrogen and phosphorus. The activity of planktonic size fractions in a tropical lake near the Amazon River was examined as part of a general investigation of the biogeochemistry of floodplains. Recycling within the plankton of this lake is the most important process supplying nitrogen and phosphorus for primary producers. Size fractionation of the plankton was used to attempt to separate different groups of organisms and to measure the rates of nitrogen and phosphorus cycling within each size fraction. Most of the phytoplankton were excluded from the smaller fractions. Regeneration of ammonium in Lake Calado appears to occur predominantly by heterotrophic plankters less than 20 micrometers. A large fraction occurs in the less than 3 micrometers, largely heterotrophic, size fraction of the plankton. More than half of the phosphorus uptake and 10 to 50 % of the ammonium uptake appears to be due to heterotrophic bacteria-sized organisms, and about one half of the ammonium regeneration appears to occur in the same fraction. (Davis-PTT)
W89-05156

RELEASE OF MAJOR IONS AND NUTRIENTS BY DECOMPOSING LEAVES OF PSEUDOBOMBAX MUNGUBA, A COMMON TREE IN THE AMAZONIAN FLOODPLAIN,
Max-Planck-Inst. fuer Limnologie zu Ploen (Germany, F.R.).
K. Furch, W. J. Junk, and Z. E. S. Campos.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IVTLAP, Vol. 23, No. 2, p 642-646, August 1988. 3 fig, 17 ref.

Descriptors: *Flood plains, *Nutrients, *Litter, *Amazon River, Varzea forest, Primary production, Oxygen content, Electrolytes, River levels, Flooding.

The decomposition of dead plant material is important in the nutrient budget of aquatic and terrestrial ecosystems. The forest floor of the floodplain of the middle Amazon is usually flooded every year for several months due to large seasonal fluctuations in river level. There, long term submergence of forest litter is a common phenomenon. A total of 4000 g of fresh leaves (corresponding to 1300 g dry) of P. munguba, a common tree of the varzea forest, was exposed for about four months to 700 liters ground water in a tank kept between 27 and 30 C. The water was not aerated during the study period and was kept in the dark, suppressing primary production and thus excluding its impact on cycling. After five days of exposure in water the leaves had lost 15% of their initial biomass and after twelve weeks the loss was 50%. At the end of the study period 40% of the original leaf mass remained. Oxygen content abruptly decreased to zero, and was followed by a long term period of anaerobic conditions, a phenomenon frequently observed in Amazonian flood plains during rising and high water level. At the beginning of the experiment, specific conductance of the water increased very rapidly, indicating a high leaching rate for the electrolytes. The electrolyte content of the water then increased more slowly, and after about 13 weeks, value of specific conductance had stabilized. During leaf decomposition, acidic, oxygen rich, and electrolyte poor water had changed to an oxygen free, electrolyte rich, neutral and, well buffered water. It is concluded that tree leaves can contribute considerable amounts of dissolved bioelements to the water in the Amazonian floodplain. (Davis-PTT)
W89-05157

RELATIONSHIPS BETWEEN AIR TEMPERATURE, DEPTH, NUTRIENTS AND CHLOROPHYLL IN 103 ARGENTINIAN LAKES,
Instituto Nacional de Investigacion y Desarrollo Pesquero, Mar del Plata (Argentina). Dept. de Aguas Continentales.
R. Quiros.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IVTLAP, Vol. 23, No. 2, p 647-658, August 1988. 2 fig, 6 tab, 42 ref. Consejo Nacional de Investigaciones Cientificas y Techicas PID 3-017400/85.

Descriptors: *Nutrients, *Chlorophyll a, *Lakes, *Limnology, Data collection, *Argentina, *Reservoirs, Total dissolved solids, Temperature, Water depth, Lake morphometry, Andes Mountains.

The mid-summer relationships between chlorophyll-a and nutrient levels, morphometry and climatic characteristics were studied in 103 Argentinian lakes and reservoirs. Surface waters were sampled by the National Institute of Fisheries and the Chubut Province during the summers of 1984, 1985, and 1986. The total set includes lakes and reservoirs on the Patagonian Plateau and Patagonian Andes Mountains, ponds and very shallow lakes on the Pampa Plain and reservoirs and ponds in the Central-West and North-West regions of Argentina. The deepest lakes are located on the Patagonian Andes Region. Their chlorphyll-a levels were below 1.0 mg/cu m. Patagonian Plateau lakes are shallower and their total dissolved solids level higher than those on the Patagonian Andes Mountain. Chlorophyll-a levels ranged from 1.0 to 80 mg/cu m. The shallow lakes on the Pampa Plain have chlorophyll-a levels as high as 400 mg/cu m. On the Central-West Region, near the Andes Mountains, chlorophyll-a ranged from 1.0 to 13 mg/cu m and on the North-West Region chlorophyll-a levels were between 1.0 and 218 mg/cu m. Most of the Patagonian Andes Lakes had total nitrogen:total phosphorus ratios above 80 and most of the Pampa lakes had ratios between 10 and 100. There were significant relationships between chlorphyll-a and midsummer surface total alkalinity and total dissolved solids. There was no relationship between lake surface area and chlorophyll-a. Mean average temperature increased the explained variance in 2 and 7% in unstratified and stratified lakes respectively and average mean depth did not explain the residual variance in the unstratified group. The following properties are tabulated for the 103 lakes and reservoirs studied: area, depth, elevation, latitude, mean air temperature, Secchi dish transparency, total phosphorus, total organic nitrogen and total chlorophyll-a. (Davis-PTT)
W89-05158

LAKES. 7. SUCCESSION: SEASONAL SUCCESSION OF PHYTOPLANKTON SIZE ASSEMBLAGES AND ITS ECOLOGICAL IMPLICATIONS IN THE NORTH AMERICAN GREAT LAKES,
Canada Centre for Inland Waters, Burlington (Ontario).
For primary bibliographic entry see Field 5C.
W89-05159

SEASONAL PHYTOPLANKTON RHO- AND K-SELECTION IN OLIGOTROPHIC LAKE TAHOE,
California Univ., Davis. Inst. of Ecology.
H. J. Carney, and C. R. Goldman.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IVTLAP, Vol. 23, No. 2, p 672-676, August 1988. 1 tab, 21 ref. NSF grants BSR-8501872 and BSR-8304916.

Descriptors: *Limnology, *Eutrophication, *Phytoplankton, *Oligotrophic lakes, *Seasonal distribution, *Lake Tahoe, Nutrients, Productivity, Growth rate, Succession type, Algae, Diatoms, Stratification, Rho-selection, K-selection, Environ-

mental factors, Limiting nutrients, Nitrogen, Phosphorus.

Lake Tahoe is a large (400 sq km surface area), deep (505 meters maximum, 313 meters mean depth) lake. The watershed is small (1.6:1 ratio of drainage basin to lake surface area) and consists primarily of nutrient poor soils which overlie granitic bedrock. Because of these watershed characteristics and the morphometry of the lake, Lake Tahoe has been ultraoligotrophic for thousands of years. The unusual features of this lake provide a rigorous test for the generality of the rho- and K-selection concept. Rho refers to the intrinsic rate of increase, and rho-selected organisms are small, fast-growing, short-lived and opportunistic species which rapidly occupy resource-rich areas. K refers to the carrying capacity, and K-selected organisms are the larger, slow-growing, long-lived and highly competitive species which use limiting resources efficiently. Data collected during a 1984-85 study were examined to test whether phytoplankton seasonality in Lake Tahoe agrees with the concept of rho- and K-selection. Several factors are generally consistent with this concept during the spring and summer: increasing water column stability, reduced nutrient concentrations, declining primary productivity and specific growth rate, and a shift from smaller short-lived cells to larger and more persistent forms. The most striking difference of this lake is its muted seasonality, which may be caused by some combination of the following factors: low nitrogen and phosphorus loadings and lack of silica depletion, unusual depth, and relatively low grazing pressure. If cultural eutrophication of this lake continues, the rate of seasonal succession will probably increase and become more typical for a north temperate lake. (Davis-PTT)
W89-05160

PHYTOPLANKTON RESPONSES TO CHANGES IN MORTALITY RATE,
Michigan Univ., Ann Arbor. Dept. of Biology.
S. S. Kilham.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IVTLAP, Vol. 23, No. 2, p 677-682, August 1988, 1 tab, 1 fig, 33 ref.

Descriptors: *Limnology, *Phytoplankton, *Seasonal variation, *Mortality, *Lakes, Temperature, Sinking, Nutrients.

Seasonal succession of phytoplankton, often in repeated patterns, is a characteristic of almost all lakes. The growth related factors most often considered are light, nutrients and temperature; the loss related factors include grazing and sinking. The possible integration of effects that increase or decrease mortality factors and hence affect the abilities of species to use potentially limiting resources within the phytoplankton community is presented as four propositions. Proposition one states that species of phytoplankton have different resource requirements. Species can be ranked by objective criteria as to their abilities to grow under limitation by particular resources. Proposition two states that phytoplankton species can exhibit tradeoffs in the ability to use limiting resources and therefore can be ranked for competitive ability along resource ratio gradients. The third proposition states that phytoplankton communities growing at different overall turnover rates are composed primarily of species with different life history characteristics. The characteristics of freshwater phytoplankton that grow at a low rate are: large, herbivore defenses, large storage capacity, and supplemental feeding strategies; examples include desmids, colonial bluegreens, large flagellates, and large diatoms. Characteristics of freshwater phytoplankton growing at a high rate include: small, easily eaten, uptake ability maximized, and no exotic requirements; examples include small greens, coccoid bluegreens, small flagellates, and small centric diatoms. Proposition four states that different phytoplankton species within a community can have simultaneously different net turnover rates. This is the reason behind phytoplankton seasonal succession. During succession, turnover rate can change depending on water motion, degree of herbivory, and degree of resource limitation. (Davis-PTT)
W89-05161

CONCEPT OF ECOLOGICAL SUCCESSION APPLIED TO SEASONAL PERIODICITY OF FRESHWATER PHYTOPLANKTON,
Freshwater Biological Association, Ambleside (England).
C. D. Reynolds.
International Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IVTLAP, Vol. 23, No. 2, p 683-691, August 1988, 4 fig, 31 ref.

Descriptors: *Limnology, *Succession, *Phytoplankton, *Seasonal distribution, *Aquatic environment, Environmental variability, Planktonic communities, Equilibrium conditions, Species competition.

Seasonal succession refers to the frequent and conspicuous temporal changes in the relative abundance and dominance of species comprising natural assemblages. Seasonal change in natural phytoplankton assemblages is best interpreted as the interaction between true successional development and intermediate disturbance. The outcome of individualistic responses to environmental variability contributes to the development of planktonic communities in particular ways. Rho-selected species tend to dominate at the early stages; late stages are dominated by plankton species recognized to be K-strategists. Intermediate transitions in community function, moving from high productivity to high efficiency, from resource exploitation to resource conservation, from weak organization to increased structural complexity, consistency and resilience to environmental change increasingly select for the replacement of rho-strategists by K-species. Few cases can be cited where equilibrium conditions are reached in natural phytoplankton assemblages. It seems likely that because allogenic environmental fluctuations, generated by variability in wind stress and solar heating at the surface, often occur at frequencies ranging between a few hours and several days, the selective advantage moves from species to species before any has had the opportunity to replace the former. Temporal changes in the composition of phytoplankton assemblages are not exclusively, nor even often, attributable to the outcome of ecological succession but rather to alternations between autogenic, equilibrium dynamics and nonequilibrium reactions of the community to allogenic, environmental variability. Customary though it has become to refer to all such changes as phytoplankton succession, the case for the restriction of this term only to autogenic development of the community is reaffirmed. (Davis-PTT)
W89-05162

ACIDIC LAKE LAKEENJARVI, EASTERN FINLAND: PHYTOPLANKTON SUCCESSION AND WATER CHEMISTRY,
Maj and Tor Nessling Foundation, Helsinki (Finland).
V. Ilmavirta.
International Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IVTLAP, Vol. 23, No. 2, p 693-698, August 1988, 9 fig, 2 tab, 20 ref.

Descriptors: *Nitrogen, *Phosphorus, *Phytoplankton, *Lake stages, *Acidic water, *Lake Lakeenjarvi, *Limnology, Finland, Water temperature, Epilimnion, Hypolimnion, Secchi disks, Seasonal variation, Oxygen, Alkalinity, Hydrogen ion concentration, Chlorophyll a, Aluminum.

In Eastern Finland, limnology, phytoplankton ecology and paleolimnology of 150 lakes have been under intensive study. The naturally acidic lake Lakeenjarvi was selected for more frequent sampling during 1984. Lakeenjarvi is a small dimictic lake with a surface area of 31.6 hectars, drainage area 84 hectars, and maximum depth 12.0 meters. The first sampling was through 65 cm ice on March 28 and the second sampling was one day after the ice melted, May 10. Epilimnion samples were collected as three subsamples per depth with 0.5 meter intervals, from the surface to the thermocline. The hypolimnion was sampled one meter above the bottom. Thermal stratification was stable in the May 10 sampling. Heating of epilimnion water followed the air temperature closely. Secchi disc transparency of the lake was least in the spring, when the dark anoxic hypolimnion water from the winter stagnation period was mixed into the whole water body. Secchi increased continuously towards midsummer having the first maximum, 8.3 m in June. The epilimnion remained clear but coloration in the hypolimnion increased. Primary production did not cause any seasonal pH variations. Phytoplankton biomass had two maxima, in the spring and in the late summer. The total biomass did not correlate with any chemical parameters, total cell number correlated only with inorganic carbon, but chlorophyll-a correlated with water color, nitrogen, phosphorus, aluminum and carbon dioxide. Correlations of different phytoplankton groups to chemical parameters were poor. In vitro primary production correlated significantly with total biomass and cell number. (Davis-PTT)
W89-05163

ALGAL CONTROL OF ELEMENTAL SEDIMENTARY FLUXES IN LAKE CONSTANCE,
Konstanz Univ. (Germany, F.R.). Limnological Inst.
H. H. Stabel.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IVTLAP, Vol. 23, No. 2, p 700-706, August 1988, 4 fig, 17 ref. Deutsche Forschungsgemeinschaft grant Ti 115/2-3.

Descriptors: *Limnology, *Phytoplankton, *Sedimentation, *Seasonal variation, *Lake Constance, Algae, Calcium carbonate, Primary productivity, Diatoms, Organic carbon, Succession.

The sedimentation of particles in lakes is a major sink for many elements. The succession of phytoplankton populations in Lake Constance was studied, together with population dynamics, and sedimentational behavior of principal diatoms. The quantity of sedimentary matter, the times of maximum settling fluxes as well as the chemical composition of the precipitates seem to be controlled by algae. The relationship of the main settling phases of predominant elements to the seasonality in the development of specific phytoplankton species was studied at a central station of the Uberlinger See, a 147 meter deep northwestern bight of mesotrophic Lake Constance. In Lake Constance the settling material is dominated by calcium carbonate, followed in order of significance by diatomaceous silica and organic matter. The seasonal fluctuations in the sedimentation rates of organic carbon were not related to seasonal changes in the phytoplankton primary productivity. The reason for this discrepancy is that many algal taxa, like flagellates, dinophyceae or buoyant cyanobacteria, do not settle as whole cells over great distances. Rather they are grazed by zooplankton or they deteriorate leaving only few solid remnants. These algae are abundant in Lake Constance. The formation of calcium carbonate resulted in a decrease of the strontium content in the euphotic zone. Allochthonous minerogenic matter contributed only little to the bulk of sedimentary matter trapped below the euphotic zone. There are also regular episodes of organic sedimentation and precipitation of calcite. The precipitation of inorganic carbon and calcium is induced by the presence of diatoms. There is a group of elements (Al, Ti, Fe, Mn, Cl) which is not affected by the diatoms. They are either conservative elements or their settling is coupled with the fluxes of allochthonous material. (Davis-PTT)
W89-05164

RESPONSE OF THE PHYTOPLANKTON COMMUNITY TO THERAPY MEASURES IN A HIGHLY EUTROPHIC URBAN LAKE (SCHLACHTENSEE, BERLIN),
For primary bibliographic entry see Field 5G.
W89-05165

LONG-TERM DYNAMICS OF PLANKTON COMMUNITIES IN LAGO MAGGIORE (N. ITALY),

Istituto Italiano di Idrobiologia, Pallanza (Italy).
For primary bibliographic entry see Field 5G.
W89-05166

PATTERNS OF TEMPORAL VARIATION IN LAKE TITICACA, A HIGH ALTITUDE TROPICAL LAKE. II. SUCCESSION RATE AND DIVERSITY OF THE PHYTOPLANKTON,
California Univ., Davis. Inst. of Ecology.
P. J. Richerson, and H. J. Carney.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IVTLAP, Vol. 23, No. 2, p 734-738, August 1988. 2 fig, 1 tab, 24 ref. NSF grant DEB 7921933.

Descriptors: *Limnoloyg, *Phytoplankton, *Temporal distribution, *Productivity, *Lake Titicaca, Biomass, Hydrological effects, Hydrological budget, Epilimnion, Statistical analysis.

Lake Titicaca is a large, high altitude monomictic, moderately productive lake in Peru and Bolivia. It is a nitrogen-limited system. Hydrological effects are small because of the large volume of the lake relative to its annual water budget. Most chemical and biological variables showed little evidence of seasonal variation. Only diatom biomass and one chemical variable showed significant evidence of regular seasonal fluctuations. Interannual variation was larger than regular seasonal variation, and irregular variations within years were an important feature of the chemical and biological series. Two simple statistical techniques were used to detect patterns in the data, based on phytoplankton enumerations from 1973 and 1981-1982. Autocorrelation estimates were made on linear interpolations of the raw data to give values with equal 14-day spacings. The Lake Titicaca phytoplankton exhibit modest evidence of regular seasonal fluctuations and major between year variations in succession rate and biomass. Much of the variation within years is apparently seasonal. None of the autocorrelation analyses show evidence of a strong seasonal cycle. Compared with typical temperate lakes, and with tropical lakes dominated by seasonal hydrology, biotic processes in Lake Titicaca show weak to negligible effects of seasonality of hydrographic processes. A strongly seasonal pattern of stratification, the absence of a strongly seasonal light regime, temperature regime, or hydrology, is apparently not sufficient to entrain most chemical and biological processes in a consistent pattern of seasonal fluctuation. (Davis-PTT)
W89-05167

ALGAL-CLAY FLOCCULATION IN TURBID WATERS: VARIATIONS DUE TO ALGAL AND MINERAL DIFFERENCES,
South Florida Water Management District, West Palm Beach.
D. M. Soballe, and S. T. Threlkeld.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IVTLAP, Vol. 23, No. 2, p 750-754, August 1988. 4 fig, 7 ref.

Descriptors: *Limnology, *Algae, *Flocculation, *Plankton, Selenastrum capricornutum, Chlorophyll a, Bentonite, Suspended algae, Silica, Kaolin, Scenedesmus.

The flocculation behavior of algae was studied in four experiments, under controlled laboratory conditions to examine the main effects and interactions of mineral type, algal concentration, and algal species in algal flocculation and estimate the relative importance of mineral and algal influences on flocculation in natural plankton communities. At high concentrations of Selenastrum capricornutum and mineral particles, bentonite produced the greatest increase in algal sedimentation. This treatment reduced the concentration of suspended algae by about 50% in 2 hr. Silica increased the sedimentation of Scenedesmus more than either the kaolin or bentonite treatments. At high algal concentration and high mineral concentration, bentonite showed the strongest flocculation effect and sedimentation was rapid. The fourth experiment focused on interactions between mineral concentration and algal concentration effects and combined four concentrations of Selenastrum with kaolin at three concentrations. In the control treatment (no mineral added), there was a slight enhancement of Selenastrum sedimentation at higher algal concentrations. Additions of kaolin increased sedimentation of Selenastrum and in both the 25 and 50 mg/L kaolin treatments, higher concentration of algae enhanced sedimentation. The differences in Selenastrum settling rate between the 50 and 25 mg/L mineral treatment were not significant. These experiments do not unequivocally demonstrate the relative importance of algal and mineral factors in algal flocculation, but it is notable that mineral-concentration or algal-species effects were more frequent than algal-concentration effects. (Davis-PTT)
W89-05168

DIURNAL CHANGES OF DIC AND DO BY PHYTOPLANKTON COMMUNITY DURING CONTINUOUS ACIDIFICATION IN EXPERIMENTAL PONDS,
National Inst. for Environmental Studies, Tsukuba (Japan). Div. of Chemistry and Physics.
For primary bibliographic entry see Field 5C.
W89-05169

LAKES. 9. MODELS: MODELING WATER QUALITY IN RESERVOIR TAILWATERS,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
For primary bibliographic entry see Field 5G.
W89-05170

APPLICATION OF THE ECOLOGICAL MODEL FINNECO TO LAKE GJERSJOEN,
Norsk Inst. for Vannforskning, Oslo.
For primary bibliographic entry see Field 5G.
W89-05172

PHYTOPLANKTON MODELLING BY MEANS OF OPTIMIZATION: A 10-YEAR EXPERIENCE WITH BLOOM II,
Waterloopkundig Lab. te Delft (Netherlands).
For primary bibliographic entry see Field 5G.
W89-05173

ECOSYSTEM MODEL FOR A LAKE WITH HIGH THROUGHFLOW,
Bayerische Landesanstalt fuer Wasserforschung, Wielenbach (Germany, F.R.).
A. Hamm, H. Remeth, and N. Schilling.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IVTLAP, Vol. 23, No. 2, p 796-800, August 1988. 3 fig, 10 ref.

Descriptors: *Water quality management, *Model studies, *Limnology, *Phytoplankton, Ecology, Lakes, Lake Kochelsee, Aquatic environment, Alpine regions, Model testing.

Ecological modelling of lakes has reached a state which makes it possible to simulate not only the height of phytoplankton production but also the development of different algae and zooplankton groups, according to the nutrient conditions and other growth influencing factors. The different forms of water use as well as the efforts of ecological protection of the aquatic environment need such differentiated predictions. It was a special aim of the Sonderforschungsbereich 81 (SFB 81), to link the basic scientific work with modern water management demands at the different research fields in the prealpine and alpine region of West Germany. The highly flooded Lake Kochelsee, a natural lake, was selected for model development. A first project of SFB 81 was related to an intensive field research program; the second project aspired to develop ecological modelling of this lake. There are two phytoplankton groups: the diatoms and the nondiatoms. Blue-greens do not play any significant role in this lake. Zooplankton are divided into the herbivorous and omnivorous groups. The observed and simulated situations in 1985 are illustrated. This year can be characterized as a relatively dry year with annual water flow below average. The model as well as the field data show two peaks of phytoplankton development. The zooplankton development was well simulated, each peak following the peak of phytoplankton. The model supplies good possibilities to describe the nutrient dynamics, the phytoplankton development and other biocoenotic functions. (Davis-PTT)
W89-05174

PARTIAL DESTRATIFICATION OF EUTROPHIC LAKES: A TOOL FOR 'ECOSYSTEM MODELLING',
Max-Planck-Inst. fuer Limnologie zu Ploen (Germany, F.R.).
H. J. Krambeck.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IVTLAP, Vol. 23, No. 2, p 801-806, August 1988. 5 fig, 2 tab, 4 ref.

Descriptors: *Model studies, *Eutrophic Lakes, *Zooplankton, *Destratification, Ecosystems, Mixing, Epilimnion, Germany, Plusssee Lake, Algae, Phosphorus, Phytoplankton, Secchi disks.

In order to disturb an aquatic ecosystem, a pump was installed in a small North German lake in spring 1986 (the Plusssee near Plon) to change the stratification pattern during the summer. The lake is naturally stratified in summer with a stable thermocline at about 4 m, the epilimnion nearly being depleted of phosphorus from May to September. During the artificial destratification of the lake, all relevant species of algae were counted and measured as well as all zooplankton species. The result of a comparison between the conditions of the undisturbed lake and the artificially mixed one is not obvious: in both cases the values of the Secchi depth, primary production and algal standing crop was about the same. The changes in carbon flow could be quantified using the model equations: the growth rate of the phytoplankton biomass is about 30% higher in the mixed lake and the growth rate of the predator (the zooplankton biomass) is about 110% higher in the mixed lake. The destratification results in a higher production of phytoplankton biomass which is directly transferred to the zooplankton. In this case the lake maintains stable conditions by controlling the algal growth with the exponential growth of the predator, which always leads to damped oscillations and stability. (Davis-PTT)
W89-05175

SIMPLE MODEL TO PREDICT WATER QUALITY IN 90 JAPANESE LAKES,
National Inst. for Environmental Studies, Ibaraki (Japan).
T. Fukushima, and K. Muraoka.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IVTLAP, Vol. 23, No. 2, p 812-827, August 1988. 15 fig, 4 tab, 21 ref.

Descriptors: *Lakes, *Limnology, *Model studies, *Oligotrophic Lakes, *Water quality, Watersheds, Meteorological conditions, Chlorophyll a, Nutrients, Chemical oxygen demand, Phytoplankton, Japan, Nitrogen, Phosphorus, Precipitation, Inflow load, Seasonal variation, Primary productivity, Retention time.

To understand the fundamental feature of lake environments a simple predictive model for water quality was attempted using data easily obtained, such as: lake dimensions, watershed areas classified by land utilization, and meteorological conditions. The model consists of three parts: the relationship between information regarding lake watershed and lake nutrient concentrations; the relationship between the nutrient concentrations in the lake and those of chlorophyll a and chemical oxygen demand derived from phytoplankton production; and the characteristics of water quality variations in a lake. Based on the data from 90 oligo-hypertrophic lakes in Japan, under continuous water surveillance from 1978 to 1982, each part was successively generated by means of statistical methods and simple physical submodels. Significant information on the effects of retention time on primary production in a lake, longitudinal changes in water quality affected by certain nondimensional

parameters were also obtained. Since fairly good agreement between observed and predicted water quality found in this model, it appears sufficiently simple and adequate for application to the detailed observation of lakes so far not investigated. (Author's abstract)
W89-05176

INTERNAL NITROGEN AND PHOSPHORUS LOADS IN LAKE ROTORUA, NEW ZEALAND,
Ministry of Works and Development, Hamilton (New Zealand). Water Quality Centre.
For primary bibliographic entry see Field 5C.
W89-05177

PREDICTION OF (CHLOROPHYLL-A) IN IMPOUNDMENTS OF SHORT HYDRAULIC RETENTION TIME: MIXING EFFECTS,
Ministry of Works and Development, Hamilton (New Zealand). Water Quality Centre.
G. B. McBride, and R. D. Pridmore.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IVTLAP, Vol. 23, No. 2, p 832-836, August 1988. 1 fig, 1 tab, 2 ref, append.

Descriptors: *Limnology, *Mixing, *Model studies, *Chlorophyll a, *Retention time, Phytoplankton, Chemostat, Plug flow, New Zealand, Lake Karapiro, Lake Matahina.

Simple mathematical models were developed to predict chlorophyll-a in outflows from impoundments of short hydraulic retention time (less than or equal to two weeks). Three mixing cases were studied: partial mixing, complete mixing (i.e., a chemostat), and plug flow. Phytoplankton growth rate is limited using logistic kinetics. Comparison of the models using dimensionless variables shows that for medium retention times and low inflow chlorophyll-a, the partial mixing and plug flow models can give substantially lower predicted concentrations than the chemostat model. Application to data from two elongated impoundments (Lakes Karapiro and Matahina, New Zealand) showed that the chemostat-logistic model is the best predictor of steady state outflow chlorophyll-a of the three model types tested. (Author's abstract)
W89-05178

SEQUENTIAL EXTRACTION OF IRON-PHOSPHATE AND CALCIUM-PHOSPHATE FROM SEDIMENTS BY CHELATING AGENTS,
Leiden Rijksuniversiteit (Netherlands). Dept. of Population Biology.
For primary bibliographic entry see Field 7B.
W89-05179

LIQUID NITROGEN PRETREATMENT IN ATP EXTRACTION FROM SEDIMENTS,
Parma Univ. (Italy). Ist. di Ecologia.
For primary bibliographic entry see Field 7B.
W89-05180

COMPARISON OF CHLOROPHYLL-A CONCENTRATIONS MEASURED BY FLUOROMETRIC HPLC AND SPECTROPHOTOMETRIC METHODS IN HIGHLY EUTROPHIC SHALLOW LAKE KASUMIGAURA,
National Inst. for Environmental Studies, Ibaraki (Japan).
For primary bibliographic entry see Field 7B.
W89-05181

MEASUREMENT OF PHYTOPLANKTON PIGMENTS IN FRESHWATER: WHERE DO WE GO FROM HERE,
Rutgers Shellfish Research Lab., Port North Norris, NJ. Dept. of Oyster Culture.
T. R. Jacobsen, H. Rai, and E. A. Nusch.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IVTLAP, Vol. 23, No. 2, p 952-956, August 1988. 1 fig, 2 tab, 21 ref.

Descriptors: *Chemical analysis, *Chlorophyll a, *Phytoplankton, Aquatic life, *Spectrophotometry, *Fluorometry, Chlorophyll b, Chlorophyllase, Chlorophyllide a.

Aquatic ecologists are faced with a myriad of choices for measuring chlorophyll a. Any of the methods routinely used can provide quantitative estimates of chlorophyll a within the inherent limitation of the method. The choice of a method for determining chlorophyll a abundance can affect interpretation of the distribution, abundance, and activity of the phytoplankton in an ecosystem. HPLC and spectrophotometrically determined chlorophyll a estimates are nearly identical at the surface. But at a 4 meter depth, HPLC determinations indicate an increase while spectrophotometric estimates indicate declining phytoplankton populations. The variation between the HPLC and spectrophotometric determinations occurs because spectrophotometric methods fail to discriminate individual chlorophyll pigments from a pigment matrix. Fluorometric detection of chlorophyll a is the other routinely used method. Although it is roughly 1000 times more sensitive than spectrophotometric methods, there are several problems. Interferences of chlorophyll b pigments can significantly affect chlorophyll a determinations. Fluorometric methods cannot distinguish other interferences, such as chlorophyllide a from chlorophyll a. Aquatic ecologist must examine the techniques that they are using for measuring chlorophyll a and realize the limitations that an individual technique imposes on the usefulness of the data obtained. (Davis-PTT)
W89-05182

VI. MAN-MADE LAKES: SOME PHYSICO-CHEMICAL ASPECTS OF LAKE SAINT-JEAN, QUEBEC, CANADA,
Quebec Univ., Sainte-Foy.
M. Ouellet, and H. G. Jones.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IVTLAP, Vol. 23, No. 2, p 961-967, August 1988. 5 fig, 1 tab, 23 ref.

Descriptors: *Water pollution effects, *Limnology, *Hydroelectric power, *Temperature, *Chlorophyll a, *Lake Saint-Jean, *Quebec, *Canada, Saguenay River, Agricultural rivers, Petite Decharge river, Pulp and paper industry, Dissolved oxygen, Deicers, Limestone, Reservoirs, Oligotrophic lakes, Lake Huron, Highway effects.

The Saguenay-Lake Saint Jean hydrographic system, located in the South Central part of the Province of Quebec, has been an important source of hydroelectric power since 1926. The temperature, water chemistry, and chlorophyll levels of this large and important Canadian reservoir are described. Unlike all other basins of large man made reservoirs in Quebec, Lake Saint-Jean, situated at an altitude of 100 m within the lowest depression of the regional Lowlands, contains postglacial thick beds of fine marine sediments. The temperature of the surface pelagic waters reaches a maximum of 21 C at the end of July and declines gradually afterward. The lake surface freezes in early December and forms an ice cover up to 1.2 m thick in April. It generally melts around the first two weeks of May. The dissolved oxygen in this lake never falls below 7.0 mg/L. The major ionic characteristics of the tributaries of the coniferous forested rivers, whose watersheds drain typical Canadian Shield Terrain, are quite different from those of the small agricultural rivers in the Lowlands. Pollution deriving from agricultural activities, pulp and paper industries, road de-icing salts and the presence of limestone beds on the south fringe of the lake are major factors. The mean concentration of total chlorophyll a for the 1974 and 1975 samplings is much higher for agricultural perturbed rivers than for the large Canadian Shield rivers. The maximum mean total chlorophyll a concentration is found at the surface on July 31st and the minimum mean on September 12th. The trophic status of Lake Saint-Jean seems to be of the oligotrophic type and quite comparable to oligotrophic Lake Huron. (Davis-PTT)
W89-05183

HEAVY METAL DISTRIBUTION AND WATER QUALITY ASPECTS OF A NEWLY IMPOUNDED GOLD MINING RESERVOIR,
Nevada Univ., Las Vegas. Environmental Research Center.
For primary bibliographic entry see Field 5B.
W89-05184

LIMNOLOGICAL CHARACTERISTICS OF LAKE OF THE OZARKS, MISSOURI II: MEASUREMENTS FOLLOWING FORMATION OF A LARGE RESERVOIR UPSTREAM,
Missouri Univ.-Columbia. School of Forestry, Fisheries and Wildlife.
J. R. Jones, and M. S. Kaiser.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IVTLAP, Vol. 23, No. 2, p 976-984, August 1988. 1 fig, 2 tab, 21 ref.

Descriptors: *Dam effects, *Reservoirs, *Limnology, *Chlorophyll a, *Phosphorus, *Lake of the Ozarks, Nitrogen, Missouri, Nitrogen, Alkalinity, Secchi disks, Osage River, Algae, Sedimentation, Reservoirs, Hydrogen ion concentration, Truman Lake, Productivity, Scour.

The limnological characteristics of Lake of the Ozarks, Missouri, during the summers of 1980 to 1986 were assessed and compared with measurements made during 1976 to 1979 to determine whether changes have resulted from the construction of Truman Lake, located on the Osage River immediately above Lake of the Ozarks. Total phosphorus, nitrogen and alkalinity all declined from 1976-1979 to 1980-1986; pH, specific conductance, and Secchi disk transparency stayed the same; chlorophyll a increased. Based on input-output models and studies in other reservoirs, the external loading of nutrient and inorganic materials to Lake of the Ozarks should be lower with Truman Lake upstream. Processes acting on impounded Osage River water, such as nutrient uptake by algae and sedimentation of particulate materials, now take place in Truman Lake before surface water from the reservoir enters Lake of the Ozarks. Lower total phosphorus concentrations in the postconstruction survey suggest decreased loading of that element. Higher chlorophyll a values suggest that the lake is more productive despite the reduction in total phosphorus. Indirect evidence suggests that conditions are more favorable for algal growth because inorganic suspended solids are lower. A down reservoir gradient in water quality dominates the limnological characteristics of the reservoir. This gradient is now caused by scouring processes in the former river channel after water passes from Truman Lake. (Davis-PTT)
W89-05185

INTER-RESERVOIR INTERACTIONS: EFFECTS OF A NEW RESERVOIR ON ORGANIC MATTER PRODUCTION AND PROCESSING IN A MULTIPLE-IMPOUNDMENT SERIES,
Oak Ridge National Lab., TN. Environmental Sciences Div.
B. L. Kimmel, D. M. Soballe, S. M. Adams, A. V. Palumbo, and C. J. Ford.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IVTLAP, Vol. 23, No. 2, p 985-994, August 1988. 4 fig, 2 tab, 20 ref.

Descriptors: *Reservoirs, *Dam effects, *Organic matter, *Limnology, *Nutrients, R. B. Russel Reservoir, Hartwell Reservoir, Clarks Hill Reservoir, Savannah River, Georgia, South Carolina, Phytoplankton, Hypolimnion.

Dam construction associated with water and power development projects has converted rivers throughout the world into regulated series of man made impoundments. Impoundment of the R. B. Russel Reservoir (RBR) between two existing reservoirs (Hartwell Reservoirs, HT, upstream and Clarks Hill Reservoir, CH, downstream) on the Savannah River (Georgia-South Carolina) provided an opportunity to investigate the limnological influence of inter-reservoir transfers of nutrients

and organic matter down a multiple impoundment series. Releases of well oxygenated water from the upper 10 m of the RBR water column minimized downstream effects of the new reservoir on CH water quality during the first year of RBR impoundment. The downstream transport of nutrients from the upper portion of the RBR hypolimnion stimulated phytoplankton production in the mid lake portion of CH during late summer. Phytoplankton production decreased markedly between July and September throughout the reservoir series as nutrient availability decreased. Spatially, phytoplankton biomass and productivity decreased downstream within reservoirs, reflecting uplake to downlake decreases in nutrient availability, but increased downstream from reservoir to reservoir, indicating increased nutrient availability down the reservoir series. The severity of hypolimnetic anoxia occurring in RBR during its first year suggested that organic matter dynamics in the new reservoir were controlled predominantly by the decomposition of inundated terrestrial organic material. (Davis-PTT)
W89-05186

BACTERIAL DENSITIES IN SELECTED SESTON FRACTIONS IN A LARGE RIVER ECOSYSTEM,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Biology.
G. M. Simmons, and M. G. Bowen.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IVTLAP, Vol. 23, No. 2, p 995-1004, August 1988. 5 fig, 1 tab, 21 ref.

Descriptors: *Trophic level, *Bacterial analysis, *Navigation, *Kanawha River, *Seston, *West Virginia, *Virginia, North Carolina, New River, Gauley River, Ohio River, Winfield Pool, Charleston, Bacterioplankton, Conductivity, Discharge capacity.

The Kanawha River ia sixth order stream and the largest northwardly flowing river in the United States. It drains an area of 7,600 square miles and receives drainage from West Virginia, Virginia, and North Carolina. The Kanawha River is formed by the confluence of the New River and the Gauley River and flows 96.4 miles to enter the Ohio River at Point Pleasant, West Virginia. A two year ecological study of the Winfield pool was conducted to evaluate the potential impact of predicted barge traffic increase on the river's trophic state in the vicinity of Charleston, West Virginia. Seston and its associated bacterial flora contribute significantly to the trophic nature of the river. Monthly collections were made from October 1982 to September 1983 at two stations in the Winfield Pool. A total of 420 slides was examined. While there was some variation in density, most were near 1,000,000 bacteria/ml. There were no significant differences in density between stations or depths. The data show a fall minimum with a return to yearly maximum levels by midwinter. The majority of bacteria occurred in the very fine size fraction; most were unattached. Attached forms showed a skewness toward the fine size fraction, and probably have a seasonal distribution pattern independent of the total community. Bacterial densities tended to show an inverse relationship to phytoplankton densities. The greatest portion of seston was tripton, followed by other phytoplankton, and then bacterioplankton. The greatest correlation with changes in bacterioplankton density was discharge and conductivity at the Lower Winfield station. (Davis-PTT)
W89-05187

NUTRIENT LOAD AND PROVISIONAL VALUATION IN AN ARTIFICIAL RESERVOIR,
Centro di Studio sulla Biologia Cellulare e Molecolare delle Piante, Milan (Italy). Dipt. di Biologia.
For primary bibliographic entry see Field 5B.
W89-05188

SEDIMENTS IN THE PERIODICALLY EXPOSED MARGINAL ZONE OF A HYPERTROPHIC RESERVOIR: THE INFLUENCE OF EXPOSURE IN PHOSPHATE EXCHANGE CHARACTERISTICS,
National Inst. for Water Research, Pretoria (South Africa).
A. J. Twinch.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IVTLAP, Vol. 23, No. 2, p 1015-1019, August 1988. 3 fig, 10 ref.

Descriptors: *Lake Sediments, *Water levels, *Cycling nutrients, *Limnology, *Phosphorus, *Reservoirs, Hypertrophic lakes, Hartbeespoort Dam, Crocodile River, Magalies River, Release rates, Water level, Phosphates.

The hypothesis that exposure of marginal lake sediments to air changes their phosphate exchange characteristics was examined in Hartbeespoort Dam, an hypertrophic impoundment. The sediments have a high phosphorus content, some of which may be released into the overlying water in the event of phosphorus load reductions. The experiments were undertaken during September and October 1982 at two places. One site was adjacent to the Crocodile River inflow, which carries about 95% of the phosphorus entering the impoundment; the other was adjacent to the relatively unpolluted Magalies River inflow. Due to the generally higher phosphorus content of sediments from the Crocodile site, phosphate release rates from sediments sampled at the Crocodile site were higher than from those sampled near the Magalies River. Exposure of marginal sediments decreased the phosphate release potential by up to 60%. In all of the cores used at the Crocodile site, phosphate flux was linearly related to phosphate concentration in the overlying water. In Hartbeespoort Dam both field and laboratory studies showed that exposure of marginal sediments resulted in a sharp reduction (up to 85%) in their phosphate release potential. These changes appeared to occur rapidly following exposure (within 48 hours at the Crocodile River site) and prolonged exposure had little additional effect. When exposed sediment cores from the Crocodile River site were stored wet in laboratory simulations of rising water levels, further reduction in phosphate release potential (or increase in phosphate uptake potential) was evident. This suggests that periodic exposure and reflooding of marginal sediments could markedly alter their role in phosphorus dynamics in the dam. (Davis-PTT)
W89-05189

COMPARISON OF P, CA AND MG CONTENTS OF PHYTOPLANKTON BETWEEN THE HEADS OF TWO RIVER RESERVOIRS WITH DIFFERENT PHOSPHORUS LOADING,
Ehime Univ., Matsuyama (Japan). Dept. of Environment Conservation.
For primary bibliographic entry see Field 5C.
W89-05190

AGRICULTURAL DEVELOPMENT AND EUTROPHICATION OF LAKE MAHINERANGI, NEW ZEALAND,
Otago Univ., Dunedin (New Zealand). Dept. of Zoology.
For primary bibliographic entry see Field 5C.
W89-05191

SMALL WATER BODIES AND WETLANDS: THE INFLUENCE OF WATER LEVEL MANIPULATION ON METAPHYTON PRODUCTION IN A TEMPERATE FRESHWATER MARSH,
Delta Waterfowl and Wetlands Research Station, Portage la Prairie (Manitoba).
For primary bibliographic entry see Field 6G.
W89-05192

BIOLOGICAL ASSEMBLAGES OF MILLER WOODS PONDS, INDIANA DUNES NATIONAL LAKESHORE, GARY, INDIANA,
Indiana Univ. Northwest, Gary. Dept. of Biology.
R. L. Whitman, A. V. Gochee, and P. L. Ruckman.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IVTLAP, Vol 23. No. 2, p 1041-1048, August 1988. 4 fig, 1 tab, 12 ref.

Descriptors: *Limnology, *Ponds, *Aquatic plants, *Aquatic animals, *Indiana Dunes National Lakeshore, Gary, Indiana, Phytoplankton, Water retention, Dredging, Zooplankton, Shallow water, Wetlands.

The Miller Woods study area, Indiana Dunes National Lakeshore, contained 28 interdunal ponds surrounded by 30 ha of black oak savanna. These ponds were generally shallow, contained no fish and consisted of vernal and aestival aquatic habitats. Many of the ponds have been destroyed by land development. Biological variation among undisturbed ponds with varying degrees of water retention were compared and the differences between natural and disturbed bodies of water were assessed. The ponds of Miller Woods possess a rich and varied assemblage of aquatic plants and animals. This diversity is likely due, in large part, to extensive littoral areas, increased habitats afforded by the plant community, varying water levels, reduced cultural disturbances and the absence of fish populations. Dredging of some ponds has increased between pond heterogeny and made specific characterization of the area even more difficult. The undisturbed ponds are excellent examples of interdunal ponds in the mature stages of aquatic succession. Aestivial ponds still retain their water with an interesting array of representative aquatic populations. A few vernal ponds maintain some residual water and are populated with environmentally tolerant and opportunistic aquatic species. During late summer, some ponds mirror wetland associations, whole drier ponds support mesic and opportunistic terrestrial species. The community differences observed between ponds suggest that care should be exercised in the generalization of seral stage biotic composition even in a restricted area such as Miller Woods. (Davis-PTT)
W89-05193

LAKE OF VIRELLES (PROV. HAINAUT, BELGIUM): MANAGEMENT OF A LAKE FOR NATURE CONSERVATION AND RECREATION,
Vrije Univ., Brussels (Belgium). Lab. voor Algemene Plantkunde en Natuurbeheer.
For primary bibliographic entry see Field 6G.
W89-05194

ALLOCHTHONOUS DETRITUS INPUT TO A SMALL, COLD DESERT SPRING-STREAM,
Battelle Pacific Northwest Labs., Richland, WA. Geosciences Dept.
C. E. Cushing.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IV TLAP, Vol. 23, No. 2, p 1107-1113, August 1988. 2 fig, 1 tab, 17 ref. DOE Contract DE-AC06-76RL0 1830.

Descriptors: *Detritus, *Deserts, *Springs, *Organic matter, *Streams, Snively Springs, Washington, Sagebrush, Steppe vegetation.

The magnitude of detritus from arid regions into Snively Springs, a small, cold desert spring stream in south central Washington was measured. The Snively Springs watershed contains a streambed approximately 7.9 km in length. Water temperatures range from 3 to 19 C. Two springs from underground aquifers provide perennial flow to the lower 4.8 km before it disappears into the desert floor. The entire drainage is located in typical desert steppe vegetation where sagebrush is the dominant shrub, and grasses make up the understory. The five distinct regions of the Snively Springs streambed include: headwaters, upper flats, canyon, transition, and lower flats. Samples of allochthonous detritus were collected in each of the five regions. In the headwaters, upper flats, and lower flats, the predominant material in the traps was several kinds of seeds, especially those modified for transport by wind, and various grass leaves and plant parts. Larger leaf and plant parts from the riparian vegetation in the canyon and the transition sections were the main constituents found in these traps. The upper flats, canyon, and transition reaches all received similar amounts of allochthonous input. The relative importance of allochthon-

ous detritus, which falls directly into a stream compared to that transported laterally in the stream, will vary from site to site. Data from Snively Springs indicate that the lateral, blow-in component may be as high as 70% in streams in arid, open regions, and that this decreases to about 50% where the stream develops a denser riparian community and/or becomes protected from the wind by hills. It is hypothesized that deposition at the spring stream terminus and subsequent export to the surrounding terrestrial environment is an important factor in organic budgets. (Davis-PTT)
W89-05196

SERIAL DISCONTINUITY IN A LARGE RIVER SYSTEM,
Montana Univ., Polson. Flathead Lake Biological Station.
For primary bibliographic entry see Field 2E.
W89-05197

COMMUNITY DYNAMICS OF BACTERIA, ALGAE, AND INSECTS IN A FIRST ORDER STREAM IN NEW HAMPSHIRE, U.S.A.,
Michigan State Univ., East Lansing. Dept. of Zoology.
T. M. Burton, K. E. Ulrich, and S. K. Haack.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IV TLAP, Vol. 23, No. 2, p 1125-1134. August 1988. 11 fig, 17 ref. NSF Grant BSR 831-5001.

Descriptors: *Aquatic life, *Chlorophyll a, *Streams, *Ecology, New Hampshire, Bacteria, Algae, Insects, Diatoms, Biomass, Stream biota, Snowmelt, Decomposition, Leaves.

Data on the bacterial, algal, and insect populations for a small headwater stream in the White Mountains of Central New Hampshire are presented with particular emphasis on insect dynamics. Chlorophyll a on glass slides remained very low from June 84 through July 85 with the largest peak occurring in June 85. Diatom counts varied with peaks in July while green and blue-green algal counts peaked at times just after leaf fall in the autumn and after snow melt and prior to canopy development in May. The peak numbers of epilithic bacteria occurred after leaf fall in Autumn and may have been related to increased carbon availability from this leaf input. Suspended bacterial cells remained constant during baseflow for most of the year. Leaf and wood decomposition took more than a year to be 80% complete. Initial colonization on leaves placed in the stream during leaf fall in 1984 was slow with insect biomass and numbers reaching an autumnal peak in late November. (Davis-PTT)
W89-05199

USE OF LONG-TERM ECOLOGICAL DATA AND SEQUENTIAL DECISION PLANS IN MONITORING THE IMPACT OF GEOTHERMAL ENERGY DEVELOPMENT ON BENTHIC MACROINVERTEBRATES,
California Univ., Berkeley. Div. of Entomology and Parasitology.
For primary bibliographic entry see Field 5C.
W89-05201

RESPONSES OF MACROINVERTEBRATES OF TWO HEADWATER STREAMS TO DISCHARGE FLUCTUATIONS,
Michigan Univ., Ann Arbor. School of Natural Resources.
For primary bibliographic entry see Field 2E.
W89-05202

DOWNSTREAM EFFECTS OF A LARGE, DEEP-RELEASE, HIGH MOUNTAIN RESERVOIR ON LOTIC ZOOBENTHOS,
Colorado State Univ., Fort Collins. Dept. of Zoology and Entomology.
J.V. Ward, and N. J. Voelz.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IV TLAP, Vol. 23, No. 2, p 1174-1178, August 1988. 3 fig, 1 tab, 12 ref.

Descriptors: *Dam effects, *Environmental effects, *Benthos, *Reservoirs, *Discharge frequency, Blue River, *Dillon Reservoir, Colorado, Alpine tundra, Subalpine forest, Mountain streams, Species diversity, trout, Diatoms, Algae.

Zoobenthic communities are contrasted at sites above and below a high mountain reservoir. Sampling was conducted monthly at sites on the Blue River, a fifth order, high gradient Rocky Mountain stream regulated by Dillon Reservoir, a large deep release storage impoundment draining a catchment of alpine tundra and subalpine forest. The upper and lower sampling sites were located on rubble riffles 0.4 km above the reservoir and 0.5 km below the dam. Annual discharge above the reservoir was near the long term mean, with the vast majority of flow occurring during the period of snowmelt runoff. Physicochemical conditions above and below the reservoir were generally favorable for mountain stream organisms, and both sites supported trout populations. The major between site differences were increased flow constancy and temperature constancy below the dam. Dense epilithon was present year round below the dam, favored by the constant flow, stable substratum, clear water, and ice-free conditions. Mean epilithon standing crops during summer, based on a timed scraping technique, were over 50 times greater at the lower sampling sites. Most rocks below the dam had dense coverings of bryophytes and filamentous chlorophytes. Rocks above the reservoir were only sparsely covered, the dominant algae being diatoms and unicellular chlorophytes. The balanced zoobenthos community above the reservoir, with rich ephemeropteran and plecopteran faunas, contrasts with the simple downstream community dominated by chironomids and turbellarians. Downstream faunal changes are attributed to the direct and indirect manifestations of the altered temperature, flow, and trophic conditions induced by stream regulation. (Davis-PTT)
W89-05203

EFFECTS OF WATERSHED VEGETATION AND DISTURBANCE ON INVERTEBRATE COMMUNITY STRUCTURE IN WESTERN CASCADE STREAMS: IMPLICATIONS FOR STREAM ECOSYSTEM THEORY,
Utah State Univ., Logan. Dept. of Fisheries and Wildlife.
C. P. Hawkins.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IV TLAP, Vol. 23, No. 2, p 1167-1173, August 1988. 3 fig, 1 tab, 16 ref.

Descriptors: *Volcanoes, *Statistical analysis, *Ecology, *Limnology, *Stream biota, *Benthos, *Mt. St. Helens, Taxonomy, Clearwater Creek, Vegetation, Ecosystems, Watersheds, Species diversity.

In 1980, the eruption of Mt. St. Helens dramatically altered 3885 km of forested landscape. In many small watersheds, streamside and hillslope vegetation was burnt, blown down, or killed. Four classes of stream watershed systems were selected for sampling. In two classes, vegetation in the entire watershed was destroyed. In the third class of watershed, forest in the lower 50 to 80% of the basin was destroyed. Vegetation in the headwater areas was not killed. In the fourth class of watershed, conifer forest and riparian vegetation in essentially all of the basin survived the eruption. Most of the watersheds selected drained into Clearwater Creek. Benthic invertebrates were collected during late August and mid-November from the lower basins of each watershed. Results of the cluster analysis did not strongly support the idea that invertebrate communities would reflect character of watershed/streamside vegetation. Clusters did not form as expected based on analysis of raw numbers of the 121 taxa collected in August. Instead, communities were moderately to strongly similar to one another. It appears that taxonomic composition and functional structure of stream communities most strongly reflects adaptation of individual taxa to physical habitat. Source of organic input is less important. Patterns of community diversity were not related to watershed vegetation. Instead, either substrate composition or proximity of colonists was most clearly associated with observed patterns. The results provide little support for the idea that community structure of consumers is tightly coupled to ecosystem function in streams. The explanatory and predictive power of trophic based models of stream ecosystems may be limited. (Davis-PTT)
W89-05204

DISTURBANCE AS A DETERMINANT OF STRUCTURE IN A SONORAN DESERT STREAM ECOSYSTEM,
Arizona State Univ., Tempe. Dept. of Zoology.
S. G. Fisher, and N. B. Grimm.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IV TLAP, Vol. 23, No. 2, p 1183-1189, August 1988. 4 fig, 2 tab, 18 ref. NSF Grant BSR 8406891.

Descriptors: *Stream biota, *Ecology, *Limnology, *Flood discharge, *Chlorophyll a, *Benthos, Deserts, Sycamore Creek, Massachusetts, Fort River, Arizona, Forests, Regression analysis, Light intensity, Temperature effects, Organic matter.

Flood effects on variables of a desert stream are described and the results compared with Fort River, a mesic stream in New England. Sycamore Creek, a spatially intermittent stream in central Arizona, drains a watershed of 505 km. Fort River, a fourth order stream in central Massachusetts, drains a largely forested watershed of 155 km above the 1700 m study reach. Discharge data for both streams were provided by the United States Geological Survey from stations near the study site, or were taken from empirical field measurements at the time of sampling. Areal water yield from the Fort River watershed is higher by a factor of 10; yet both absolute and relative magnitudes of the typical flood are less. While Sycamore Creek floods are on average 67 times mean flow, Fort River events are just 14 times mean annual discharge. Flood frequency is much lower in the desert, with 5.5 floods per year in Sycamore Creek and 30 per year in the New England stream. Biologic state variables fluctuate throughout the year in both of these ecosystems. Benthic chlorophyll a for which data are available in both systems, is much more variable in Sycamore Creek than in Fort River. Results of the multiple regression analysis indicate that only light explains significant variation in Fort River chlorophyll a, while three variables are correlated with Sycamore Creek chlorophyll a, supporting the hypothesis that floods have more influence on biologic states in the desert than the mesic stream. Total organic matter of Sycamore Creek is correlated only with discharge at the time of sampling and temperature. The results support the hypothesis that discharge related disturbance explains much of the biologic variation of desert streams. (Davis-PTT)
W89-05206

PRODUCTION OF SOLUBLE, HIGH MOLECULAR WEIGHT PHOSPHORUS AND ITS SUBSEQUENT UPTAKE BY STREAM DETRITUS,
Oak Ridge National Lab., TN. Environmental Sciences Div.
P. J. Mulholland, R. A. Minear, and J. W. Elwood.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IV TLAP, Vol. 23, No. 2, p 1190-1197, August 1988. 5 fig, 21 ref.

Descriptors: *Ecology, *Limnology, *Phosphorus, *Detritus, *Sediments, Walker Branch, Tennessee, Stream water, Orthophosphate, Laboratory studies, Stream biota.

Results from a laboratory study are reported which indicate that some of the soluble phosphorus released by microbes associated with coarse and fine detritus in streams is of relatively high molecular weight (greater than 5000 daltons) and that this phosphorus is utilized subsequently, but at rates considerably lower than for orthophosphate. Coarse particulate organic matter and fine sediments were collected from the streambed of Walker Branch, a first order woodland stream in

eastern Tennessee. Most of the phosphorus released to stream water during laboratory incubations of stream water and detritus was orthophosphate or compounds of low molecular weight. There was an accumulation of phosphorus compounds of high molecular weight because their utilization rate was considerably lower than that for orthophosphate. Despite the rapid uptake of orthophosphate and its net conversion to soluble nonorthophosphate compounds, the phosphorus pool frequently measured in water was in apparent steady state during incubations. The results indicate that soluble nonorthophosphate compounds may be an increasingly important phosphorus resource to stream biota with increasing distance downstream from springs or other point sources of orthophosphate. (Davis-PTT)
W89-05207

MICROBIAL ACTIVITY AND PHOSPHORUS UPTAKE ON DECOMPOSING LEAF DETRITUS IN A HETEROTROPHIC STREAM,
Oak Ridge National Lab., TN. Environmental Sciences Div.
J. W. Elwood, P. J. Mulholland, and J. D. Newbold.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IV TLAP, Vol. 23, No. 2, p 1198-1208, August 1988. 6 fig, 1 tab, 22 ref.

Descriptors: *Microbial degradation, *Artificial watercourses, *Limnology, *Ecology, *Phosphorus, *Detritus, *Leaves, Heterotrophic streams, White oak, Dogwood, Red maple, Respiration rate.

The influence of microbes associated with decomposing leaf detritus on the uptake length and retention of phosphorus in a heterotrophic stream is reported. The work was conducted in a once through, experimental stream channel constructed of Fiberglass. The uptake length of PO4-P in water peaked immediately after leaves were added to the stream, decreased to a minimum by day 20, and then increased slightly thereafter. Area-specific uptake rate of PO4-P by all three leaf species increased and then decreased with time; the maximum uptake rate on white oak leaves occurred approximately two weeks after that on dogwood and red maple leaves. Microbial biomass on the leaves also increased and then decreased with time in the stream, reaching a maximum on all three species of four weeks. Electron transport system activity (ETSA) associated with white oak leaves showed no consistent temporal pattern; ETSA associated with dogwood and red maple leaves generally increased with time in the stream, reaching a maximum after six weeks and then declining. Respiration rate of microbes on all three leaf species increased with time to a maximum after four to five weeks and then decline. Net phosphorus content of white oak leaves increased with time from day 3 to day 49 and then declined. Concentrations of SRP at the stream outlet were generally less than or equal to those at the inlet. Net immobilization of phosphorus by decomposing leaf detritus has potentially important implications to the available supply of phosphorus in streams. Almost one-half of the phosphorus taken up from stream water is immobilized in leaf detritus during the initial period of leaf decomposition. (Davis-PTT)
W89-05208

STRUCTURE AND FUNCTION OF A BLACKWATER RIVER IN THE SOUTHEASTERN U.S.A.,
Alabama Univ., University. Aquatic Biology Program.
A. C. Benke, and J. L. Meyer.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IV TLAP, Vol. 23, No. 2, p 1209-1218, August 1988. 4 fig, 3 tab, 35 ref. NSF Grants DEB-8104427, BSR-8406630, BSR-8406631.

Descriptors: *Limnology, *Swamps, *Sediments, *Flood plains, *Ogeechee River, Organic matter, Piedmont Plateau, Savannah, Georgia, Coastal Plain, Detritus, Ecosystems, Seston.

Blackwater streams in the Coastal Plain of the southeastern United States differ substantially from most published views of stream ecosystems, such as the River Continuum Concept. Although data is presented only on the main sixth order segment of the Ogeechee River, much of the entire drainage basin consists of sinuous low gradient streams with floodplain swamps. Organic matter measured during autumn low water is high in the main channel and consists primarily of fine particulate organic matter in the sediments (21%) and woody debris (70%). The concentration of detrital organic matter in the forested swamps is comparable to that in the channel, but 83% is in the soil. The swamps are flooded virtually every year, often for three to four months, during which time there is mixing of river and swamp waters. The floodplains appear to be responsible for supplying much of the organic matter in transport of which more than 96% is dissolved organic matter. the swamp inputs are consistent with the high degree of heterotrophy in the Ogeechee. The particulate organic matter in transport is primarily fine amorphous material, but appears to be a rich food resource with 43% of the seston made up of live organisms. High numbers of gathering and microfiltering collectors found in both main channel sediments and snag habitats are able to utilize this food resource. (Author's abstract)
W89-05209

YEARLY FLUX OF VIRUS-LIKE PARTICLES AND HUMIC ACID IN RIVER SEDIMENT,
Davidson Coll., NC. Dept. of Biology.
For primary bibliographic entry see Field 5A.
W89-05210

CHANGES OF COPEPODA POPULATIONS IN LAKE KINNERET DURING 1969-1985,
Kinneret Limnological Lab., Tiberias (Israel).
M. Gophen.
Hydrobiologia HYDRB8, Vol. 167/168, p 375-379, October 15, 1988.

Descriptors: *Limnology, *Lake Kinnaset, *Israel, *Copepods, *Population dynamics, *Israel, *Lakes, Population density, Aquatic populations, Predation.

Long period analysis of Copepoda populations in Lake Kinneret indicated significant reductions in total biomass and production as well as densities of nauplii and adult stages, particularly females. The reduction of adult Mesocyclops sp. was statistically significant, but that of Thermocyclops sp. was not. Annual averages of eggs/female values and densities of copepodite states did not show significant changes. Concentrations of adult Thermocyclops sp. became higher relative to the larger genus Mesocyclops sp. It is suggested that densities of large copepods were affected by intensification of predation pressure by particulate feeding fishes. The densities of nauplii were probably reduced by increased predation pressure of filter feeding fish. (Author's abstract)
W89-05252

DISTRIBUTION OF THREE NYMPHAEID MACROPHYTES (NYMPHAEA ALBA L., NUPHAR LUTEA (L.) SM. AND NYMPHOIDES PELTATA (GMEL.) O. KUNTZE) IN RELATION TO ALKALINITY AND UPTAKE OF INORGANIC CARBON,
Katholieke Univ. Nijmegen (Netherlands). Lab. of Aquatic Ecology.
For primary bibliographic entry see Field 5C.
W89-05256

ISOETID-ZOOBENTHOS ASSOCIATIONS IN ACID-SENSITIVE LAKES IN ONTARIO, CANADA,
Toronto Univ. (Ontario). Inst. for Environmental Studies.
For primary bibliographic entry see Field 5C.
W89-05257

CRITICAL CONCENTRATIONS OF TISSUE NITROGEN AND PHOSPHORUS FOR GROWTH RATE AND YIELD IN THE FRESHWATER BLUE-GREEN ALGA MICROCYSTIS AERUGINOSA KUTZ. IN THE TROPICS,
Asian Inst. of Tech., Bangkok (Thailand).
For primary bibliographic entry see Field 2I.
W89-05260

POPULATION STRUCTURE OF STREAM-DWELLING DARTERS: CORRESPONDENCE WITH HABITAT STRUCTURE,
University of Southern Mississippi, Hattiesburg. Dept. of Biological Sciences.
C. Rakocinski.
Environmental Biology of Fishes EBFID3, Vol. 23, No. 3, p 215-224, November 1988. 5 tab, 30 ref.

Descriptors: *Limnology, *Fish populations, *Population dynamics, *Perch, *Aquatic habitats, *Ecological distribution, *Darters, Stream biota, Ecotypes, Statistical analysis, Population density.

Patterns of ecotopic variation in the population structure of two common and related Percina species were examined among seven central Gulf-Coast stream sites by Kendall's concordance tests, revealing four complexes of variables with significant covariation from a total of 18 population and habitat variables. The first complex comprised three interrelated habitat variables, implying that mid-stream surface current varied inversely with both instream cover and substrate heterogeneity. The second complex of five interrelated variables revealed that darter abundance was better correlated with the area of instream cover than with total area, and that site density (number per sq m) varied inversely with site area. Along with three other variables, cover density (number per sq meter of instream cover) formed a third complex, demonstrating resource complementarity between instream cover and macroinvertebrate abundance. Variables within the fourth complex all increased concomitantly with the key variable of mean darter size, including body-size diversity, biomass, relative abundance of the two darter species and mid-stream depth. Within the study region, local ecological factors largely regulate distributions, abundances and size-structures of Percina populations, apparently even outweighing the effect of stochastic and historical factors. (Author's abstract)
W89-05261

EMPIRICAL MODELS FOR TROPHIC STATE IN SOUTHEASTERN U.S. LAKES AND RESERVOIRS,
Duke Univ., Durham, NC. School of Forestry and Environmental Studies.
K. H. Reckhow.
Water Resources Bulletin WARBAQ, Vol. 24, No. 4, p 723-734, August 1988. 7 fig, 10 tab, 22 ref.

Descriptors: *Lakes, *Reservoirs, *Trophic level, *Cycling nutrients, *Algae, *Model studies, *Limnology, Seasonal variation, Eutrophication, Ecosystems, Chlorophyll, Phosphorus, Nitrogen, Regression analysis.

A cross-sectional data set of 80 lakes and reservoirs in nine southeastern states was examined to specify and determine parameters for trophic state relationships. The relationships fitted are based on measurements of several limnological variables taken over the course of a growing season or year in each of the lakes. The trophic state models relate phosphorus and nitrogen loading to inlake phosphorus and nitrogen concentrations, which in turn are related to maximum chlorophyll level, Secchi disk depth, dominant algal species, and hypolimnetic dissolved oxygen status. Due to the empirical nature of the study, causal conclusions are limited; rather, the models are most useful for prediction of average growing season conditions related to trophic state. (Author's abstract)
W89-05262

EFFECTS OF SPATIAL ORIENTATION OF MULTIPLE PLATE ARTIFICIAL SUBSTRATES ON INVERTEBRATE COLONIZATION,

Geological Survey, Menlo Park, CA. Water Resources Div.
For primary bibliographic entry see Field 7B.
W89-05268

LEAF LITTER BREAKDOWN IN A RECENTLY IMPOUNDED RESERVOIR,
Army Engineer Waterways Experiment Station, Spring Valley, WI. Eau Galle Lab.
W. F. James, R. H. Kennedy, W. E. Shain, and R. K. Myers.
Water Resources Bulletin WARBAQ, Vol. 24, No. 4, p 831-837, August 1988. 6 fig, 3 tab, 16 ref.

Descriptors: *Limnology, *Biodegradation, *Reservoirs, *Decomposing organic matter, *Leaves, *Litter, *Biomass, *Cycling nutrients, Lakes, Organic matter, Leaching, Nitrogen, Phosphorus, Physicochemical properties, Forest hydrology.

The impoundment of Richard B. Russell Lake resulted in the inundation of 3490 ha of forested area or 33 of the total area of the lake. Estimates of the total inundated leaf litter biomass were combined with a leaf litter decomposition study to determine the nutrient load and dissolved oxygen demand to the reservoir. Hickory leaf bags broke down most rapidly at the 3-m and 28-m depths, followed by short-needle pine, white oak, a hardwood litter mixture, beech, and red oak. Leaf bags incubated t the 3-m depth exhibited significantly higher breakdown rates than those at the 28-m depth for most leaf types, due to differences in dissolved oxygen and temperature. Respiration rates of litter were also higher at the 3-m depth. Most leaf types accumulated nitrogen and phosphorus and lost organic carbon after an initial leaching period. Richard B. Russell Lake exhibited extensive anoxia and the buildup of total organic carbon, nitrogen, and phosphorus during summer stratification. Leaf litter breakdown accounted for 64 of the organic carbon increase but acted as a sink for nitrogen and phosphorus. The dissolved oxygen demand of the litter accounted for over 50 of the demand incurred in the lake. (Author's abstract)
W89-05273

EFFECTS OF NUTRIENT DEPLETION ON THE SINKING VELOCITY AND CELLULAR COMPOSITION OF A FRESHWATER DIATOM,
British Antarctic Survey, Cambridge (England).
M. C. Davey.
Archiv fuer Hydrobiologie AHYBA4, Vol. 112, No. 3, p 321-334, May 1988. 2 fig, 3 tab, 39 ref.

Descriptors: *Diatoms, *Zooplankton, *Cycling nutrients, *Growth kinetics, *Population dynamics, *Limiting factors, *Limnology, Ecosystems, Aquatic populations, Inhibition, Photosynthesis, Phosphorus, Silicon, Biochemistry.

The planktonic, freshwater diatom Asterionella formosa Hass was grown in batch culture until growth was limited by silicon or phosphorus availability. Limitation of growth by either nutrient led to an increase in colony sinking velocity and a decrease in colony density. In the case of silicon-limitation these effects occurred when ambient silicon was exhausted, but in the case of phosphorus-limitation they were delayed until the cellular reserves of phosphorus were exhausted. Lower sinking velocities and higher densities were recovered on addition of the limiting nutrient in excess. All such changes occurred rapidly (< 1 day) and following the initial changes, no further variation occurred. Following limitation of growth by either nutrient, photosynthesis appeared to continue leading to an increase in the cellular content of protein in silicon-limited cells or carbohydrate in phosphorus-limited cells. The decreases in colony density are explained by increases in cell volume, there being no decrease in the cell's dry weight. The increase in sinking velocity may also have been partly caused by the increase in cell volume, but this cannot provide a full explanation. Variations in diatom sinking velocities in response to the prevailing nutrient regimes have important consequences for the vertical distribution of the diatom in the natural environment, in particular in the formation of midwater maxima. (Author's abstract)
W89-05280

PHYSICAL AND CHEMICAL CHARACTERISTICS OF LAGO RUPANCO, OSORNO, CHILE,
Instituto Profesional Osorno (Chile).
T. G. Donoso, and H. K. Phinney.
Archiv fuer Hydrobiologie AHYBA4, Vol. 112, No. 3, p 351-369, May 1988. 16 fig, 1 tab, 24 ref.

Descriptors: *Lakes, *Chile, *Oligotrophic lakes, *Limnology, *Physicochemical properties, *Lake classification, *Seasonal variation, Physical properties, Chemical properties, Cycling nutrients, Water properties, Euphotic zone, Water temperature.

Lago Rupanco is located in the central plain of Chile at 40 degrees 50 minutes south; 72 degrees 30 minutes west. It lies at 117 m above sea level, and corresponds to type 28c of Hutchinson's (1967) classification. Lago Rupanco is a warm, monomictic lake, with winter circulation and summer stratification. Physical and chemical parameters of this lake were studied during a cycle of 18 months for the first time in 1981-1982. Lago Rupanco has a maximum depth of 160 m. The euphotic zone was sampled and the temperature ranged from 10 to 18 C with an oxygen content between 9 and 11 mg/L. This lake had small amounts of nitrate-nitrogen and phosphate-phosphorus, as is characteristic of oligotrophic lakes. Secchi disc transparency varied from 10-20 m, with greater transparency during October to April and less during May-September. The lake had the following characteristics: ;H 6.8 to 7.2; CO2 concentration of 1-8 mg/L; ammonia N concentration of 10-20 microgm/L in spring and summer and 0-5 microgm/L in fall and winter; nitrite N was not detected. (Freemann-PTT)
W89-05282

INFLUENCE OF THE ENVIRONMENT ON WILLOW LEAF LITTER DECOMPOSITION IN THE ALLUVIAL CORRIDOR OF THE GARRONE RIVER,
Centre National de la Recherche Scientifique, Toulouse (France). Centre d'Ecologie des Ressources Renouvelables.
E. Chauvet.
Archiv fuer Hydrobiologie AHYBA4, Vol. 112, No. 3, p 371-386, May 1988. 4 fig, 43 ref.

Descriptors: *Limnology, *Biodegradation, *Garonne River, *Decomposing organic matter, *Leaves, *Litter, *Model studies, Willow trees, Physicochemical properties, Decomposition, Standing water, Vegetation effects, Organic matter.

A net bag method was used to study the decomposition of Salix alba leaves in five Garonne corridor sites (fast running water, slow flowing water, standing water, floodable willow stand, non-floodable willow stand). Changes in the contents and the amounts of some leaf litter constituents were assessed over a 40 week period. Willow leaves decomposed rapidly and, in some cases, this could be described by an exponential model (k = 0.0040 to 0.0121/d depending on site). Carbon content was rather stable. An absolute increase in nitrogen was observed at all sites for the first weeks. Cellulose loss was less rapid in slow flowing or standing waters and on floodable soils. The lignin fraction accumulated rapidly and was generally 50% after 40 weeks. Decomposition rates were not significantly different at aquatic and terrestrial sites. Both in waters and on soils, oxygen levels and temperature control the decomposition kinetics, especially of cellulose and lignin. (Author's abstract)
W89-05283

GROWTH OF PERCH, PERCA FLUVIATILIS L., IN RECENTLY ACIDIFIED LAKES OF SOUTHERN FINLAND - A COMPARISON WITH UNAFFECTED WATERS,
Helsinki Univ., Lammi (Finland). Lammi Biological Station.
For primary bibliographic entry see Field 5C.
W89-05284

SEASONAL AND ANNUAL VARIATIONS IN THE ABUNDANCE OF PELAGIC SARDINES IN LAKE KARIBA, WITH SPECIAL REFERENCE TO THE EFFECTS OF DROUGHT,
Zimbabwe Univ., Harare. Dept. of Biological Sciences.
B. E. Marshall.
Archiv fuer Hydrobiologie AHYBA4, Vol. 112, No. 3, p 399-409, May 1988. 6 fig, 2 tab, 16 ref.

Descriptors: *Lake Kariba, *Limnology, *Fish populations, *Sardine, *Lakes, *Seasonal variation, *Food chains, *Cycling nutrients, *Drought, Physicochemical properties, Catchment areas, Tributaries, Aquatic populations, Phytoplankton, Zooplankton, Fish harvest, Africa, Population dynamics.

The introduced sardine, Limnothrissa miodon, is now the most important fish species in Lake Kariba, a very large African man-made lake. It has a distinct seasonal cycle of abundance, related to that of the zooplankton on which it feeds. This is dependent on the seasonal physico-chemical cycle of the lake. Sardine abundance is also influenced by the flow of the tributary rivers that drain into the lake and carry nutrients from their catchment areas. Low flow in these rivers leads to reduced sardine populations, which was shown clearly by reduced catches following a series of droughts. Evidence suggests that poor river flows lead to two nutrient levels in the hypolimnion resulting in low plankton populations and poor sardine catches at the time of turnover when the highest catches are usually made. This suggests that climate factors are important conditions in the management of pelagic fisheries in man-made lakes. (Author's abstract)
W89-05285

MODEL OF TEMPERATURE INDUCED DENSITY CURRENT IN WATERSIDE REEDBELTS OF LAKE CONSTANCE-UNTERSEE (EIN STROMUNGSMODELL DER TEMPERATUR-INDUZIERTEN DICHTESTROMUNG IN GESCHLOSSENEN UFERROHRICHTEN DES BODENSEE-UNTERSEES),
Fachhochschule Konstanz (Germany, F.R.).
P. Meissner, and W. Ostendorp.
Archiv fuer Hydrobiologie AHYBA4, Vol. 112, No. 3, p 433-448, May 1988. 9 fig, 18 ref.

Descriptors: *Density currents, *Limnology, *Model studies, *Water currents, *Reeds, *Channel flow, *Flow velocity, *Lake morphology, Hydrologic properties, Lake beds, Flow characteristics, Fluid mechanics, Lake Constance, Hydrodynamics, Physical properties, channel morphology.

On the basis of literature data a model developed for lake Constance-Untersee that allows estimation of the significance of parameters such as stalk density and diameter, water depth, roughness of the bottom etc. for the deceleration of the current velocity within the reed belt. A simple channel current was modeled. Lake current is driven by the density difference between the water bodies inside and outside the reeds, which is caused by temperature difference. In the model, the drive is replaced by the slope of the channel floor in the gravity field. Under natural conditions, a lakeside counter current exists close to the bottom below the surface current, which is directed to the shoreside. The simple channel model has to be adapted to field conditions and is transformed to a more detailed 'two-currents-model.' The reed belt current can thus be computed, provided the drive is kept constant. The result was that the stand structures of the reeds influence the deceleration of the current greatly, whereas roughness of the bottom, vertical distribution of velocity, and cross section ratio of input and output current are of minor importance. The data demonstrated that the rate of water exchange is higher in nutrient-limited than in 'normal' (i.e., eutrophic) stands provided that hydromechanical parameters are comparable. The reedbelt current is lowest in mown reeds. Hence, mowing is not generally a suitable measure to improve oxygen supply and to enlarge release and transportation of nutrients and dissolved organic substances out of the reedbelts. (Author's abstract)
W89-05286

SPECTRAL DISTRIBUTION OF DOWNWELLING LIGHT IN NORTHERN WISCONSIN LAKES,
Wisconsin Univ.-Madison. Center for Limnology.
C. J. Watras, and A. L. Baker.
Archiv fuer Hydrobiologie AHYBA4, Vol. 112, No. 4, p 481-494, June 1988. 6 fig, 5 tab, 25 ref.

Descriptors: *Wisconsin, *Spectral analysis, *Limnology, *Light penetration, *Lakes, *Optical properties, Water properties, Opacity, Dissolved organic matter, Chlorophyll, Photosynthesis, Phytoplankton, Physicochemical properties, Radiometry, Colorimetry, Oligotrophic lakes, Mesotrophic lakes.

The special characteristics of downwelling light were determined for seven lakes in the Trout Lake region of Wisconsin (46 degrees N, 89 degrees W) during late summer. Most of the lakes were subjects of early studies in limnological optics during the era of Birge and Juday. They are mesotrophic to oligotrophic systems that vary in organic color from 0 to > 260 PCU. Scans were made with an underwater spectroradiometer at 1 M to 5 M depth intervals to measure the wavelength-specific quantum flux between 350 nM and 850 nM. The readings were integrated over 2 nm steps in this wavelength range. The results clearly show how the spectral distribution of light in a given lake is progressively compressed into a relatively narrow region with depth. Increasing concentrations of dissolved and/or colloidal humic material between lakes is accompanied by a shift in this spectral region from green to red light; and the ratio, r sub c = (quantum flux sub (490 to 620 nM))/(quantum flux sub (620 to 750 nM)), effectively separates lakes on the basis of organic staining. Although the selectively attenuating effects of phytoplankton were secondary to the gelbstoff effect, absorption by two photosynthetic pigments, chlorophyll-a and phycocyanin, was indicated beneath thin plankton layers in some lakes with red light at depth. (Author's abstract)
W89-05289

IMPACT OF NUTRIENT INPUT FROM THE RIVER SEINE ON PHYTOPLANKTON POPULATIONS IN A SAND-PIT LAKE (BIGNAN, NW FRANCE),
Ecole Normale Superieure, Paris (France). Lab. d'Ecologie.
For primary bibliographic entry see Field 5C.
W89-05291

EXTRACT PREPARATION AND COMPARISON OF FLUOROMETRIC, CHROMATOGRAPHIC (HPLC) AND SPECTROPHOTOMETRIC DETERMINATIONS OF CHLOROPHYLL-A,
Zurich Univ., Kilchberg (Swizerland). Hydrobiological-Limnological Station.
For primary bibliographic entry see Field 7B.
W89-05292

COLONIZATION OF LEAF LITTER BY AQUATIC HYPHOMYCETES IN A TROPICAL STREAM,
Mangalore Univ. (India). Dept. of Biosciences.
K. R. Sridhar, and K. M. Kaveriappa.
Archiv fuer Hydrobiologie AHYBA4, Vol. 112, No. 4, p 627-630, June 1988. 1 tab, 14 ref.

Descriptors: *Vegetation establishment, *Stream biota, *Tropical regions, *Biodegradation, *Leaves, *Litter, *Aquatic fungi, Seasonal variation, Water analysis, Aquatic populations, Biodegradation, Decomposing organic matter, Biomass.

Eight types of submerged leaves were collected at quarterly intervals over a period of one year from Neriya stream flowing through the Western Ghat forests of Karnatska to test the colonization of aquatic hyphomycetes. A total of 23 species of hyphomycetes were colonized on them. The leaves of Ficus bengalensis harbored more of hyphomycetes; they were followed by leaves of Mangifera indica, Tectona grandis and Gleichenia pectinata, whereas Artocarpus heterophyllus harbored the fewest hyphomycetes. The fungi such as Lunulospora curvula, Triscelophorus acuminatus, T. monosporus and Triscelaphorus sp. were more frequent and colonized 5-7 kinds of leaf materials, whereas Alatospora acuminata, Flagellospora curvula, Isthmotricladia gombakiensis, I. laensis, Larisospora appendiculata, Tricladium brunneum, Tricladium sp. 1 and Tricladium sp. 2 were less frequent and colonized on any one of the leaf materials tested. The mode of colonization is discussed in relation to seasonal occurrence and substrate preference. (Author's abstract)
W89-05293

BENTHIC FAUNA OF ETHIOPIAN MOUNTAIN STREAMS AND RIVERS,
Waterloo Univ. (Ontario). Dept. of Biology.
A. D. Harrison, and H. B. N. Hynes.
Archiv fuer Hydrobiologie Supplement AHBSA8, Vol. 1, p 1-36, June 1988. 1 fig, 5 tab, 71 ref.

Descriptors: *Rivers, *Mountains, *Benthic fauna, *Ethiopia, *Stream biota, *Population dynamics, Aquatic animals, Aquatic populations, Drought, Tributaries, Soil erosion, Succession, Population density, Biomass, Species diversity.

A faunal standard of reference is established for Ethiopian montane benthos in undamaged high-level streams and rivers. The effects of population density, soil erosion and drought on source waters is described. The occurrence of specific faunal populations are outlined for the source zone, stony runs and torrents, backwaters and 'quiet spots,' moss in torrents, marginal vegetation, and slow-flowing streams. The Ethiopian montane aquatic fauna is compared with the faunas of other African mountain regions and its biogeographical significance is discussed. Among the major findings are the fact that the fauna of high altitude Ethiopian streams is typical of that of cool streams over much of Africa, but it lacks several taxa that are present south of the dry country of northern Kenya. It also includes, like the terrestrial flora, a few elements of apparently recent Palaearctic origin. The recent increase in human population of the Ethiopian highlands has led to severe soil erosion, which has in turn eliminated several groups of invertebrates, severely simplifying the fauna. (Friedmann-PTT)
W89-05294

LIMNOLOGICAL STUDY OF LAKE LLANQUIHUE (CHILE) MORPHOMETRY, PHYSICS, CHEMISTRY, PLANKTON, AND PRIMARY PRODUCTIVITY,
Universidad Austral de Chile, Valdivia. Inst. de Zoologia.
H. Campos, W. Steffen, G. Aguero, O. Parra, and L. Zuniga.
Archiv fuer Hydrobiologie Supplement AHBSA8, Vol. 1, p 37-67, June 1988. 13 fig, 9 tab, 34 ref.

Descriptors: *Plankton, *Limnology, *Lake morphometry, *Physicochemical properties, *Primary productivity, *Chile, Oligotrophic lakes, Lakes, Cycling nutrients, Biomass, Thermal stratification, Stratification, Lake morphology, Chemical properties, Seasonal variation, Aquatic animals, Phytoplankton, .

Lake Llanquihue is located at latitude 41 degrees 8 minutes S and 72 degrees 47 minutes W at an altitude of 51 m above sea level. It is the second largest lake in Chile (area 870.5 sq km). It is a type 28c lake according to its glacial origin (Hutchinson 1957). A bathymetric map (maximum depth: 317 m, mean depth: 182 m) was established for the first time. According to the physical and chemical data, this lake is oligotrophic, warm-monomictic with winter circulation at 10.5 C and summer stratification, high transparency (21 m maximal, Secchi disk). The catchment area is small in relation with the surface area. The theoretical renovation of the volume of water calculated from the relation of lake volume to affluent is 74 years. The lake obtains from its affluents the main nutrients (nitrogen, phosphorus and silica), which concentrate in the hypolimnion during the thermic stratification, impoverishing the epilimnium with a low ratio N:P. The cycle of these nutrients seems to show that the greater primary productivity takes place in winter and early spring, with a decrease in summer. The concentration of chlorophyll, abundance and biomass of the phytoplankton show the same tendencies as the productivity. During the stratification period, the winter and beginning of spring, diatoms (especially species of Melosira, Cyclotella and Synedra) are replaced by more abundant species of Chlorphyceae (Botryococcus braunii, Kirchneriella obesa, Eutetramorus fottii and Staurastrum spp.), Xantophyceas (Tribonema elongatum), Chryosphyceae (Dinobryon divergens) and Dinophyceae (Peridnium willei). The zooplankton presented a high abundance of Rotifera with a minimum at the beginning of summer, after the maximum development of phytoplanktonic biomass. Zooplanktonic larvae predominate during the winter circulation, adult, and copepodites during the stratification. (Author's abstract)
W89-05295

DIEL PATTERNS OF PHOTOSYNTHATE BIOSYNTHESIS BY PHYTOPLANKTON IN PERMANENTLY ICE-COVERED ANTARCTIC LAKES UNDER CONTINUOUS SUNLIGHT,
Montana State Univ., Bozeman. Dept. of Biology.
J. C. Priscu, L. R. Priscu, C. Howard-Williams, and W. F. Vincent.
Journal of Plankton Research JPLRD9, Vol. 10, No. 3, p 333-340, May 1988. 4 fig, 1 tab, 17 ref.
NSF Grant INT 8412682.

Descriptors: *Ice cover, *Limnology, *Biosynthesis, *Iced lakes, *Antarctic, *Phytoplankton, *Solar radiation, Ice cover, Optic properties, Biochemistry, Metabolism, Lipids, Sunlight, Lakes, Biochemistry, Photosynthesis, Lake ice, Light penetration, Diurnal distribution.

Diel patterns of photosynthate biosynthesis by Antarctic freshwater phytoplankton growing under the variable but continuous sunlight of summer were found to be similar in many respects to those reported from other aquatic environments where light/dark periods alternate. Lipid synthesis by freshwater phytoplankton in Lakes Vanda and Fryxell predominated during periods when solar radiation and photosynthesis were most intense; the inverse was generally true of the protein and polysaccharide fractions. The major photosynthetic end-products in both lakes were protein and polysaccharide, which together accounted for 60-81% of the total cellular carbon incorporation. Less than 4% of the carbon was incorporated into lipid in Lake Vanda; > 12% appeared in the lipid fraction in Lake Fryxell. The Lake Fryxell populations showed evidence of photoinhibition of complete photosynthesis during 'midday,' when irradiance was most intense. Irradiance level values, computed from the photosynthesis irradiance relationships in Lake Fryxell, corroborate other studies suggesting that the phytoplankton populations in permanently ice-capped Antarctic lakes are among the most shade-adapted yet reported. (Author's abstract)
W89-05296

SPATIAL DISTRIBUTION OF ZOOPLANKTON IN A SHALLOW EUTROPHIC LAKE, WITH A DISCUSSION OF ITS RELATION TO FISH PREDATION,
University of East Anglia, Norwich (England). School of Biological Sciences.
M. Cryer, and C. R. Townsend.
Journal of Plankton Research JPLRD9, Vol. 10, No. 3, p 487-501, May 1988. 3 fig, 2 tab, 63 ref.

Descriptors: *Fish food organisms, *Limnology, *Food chain, *Zooplankton, *Predation, *Eutrophic lakes, *Spatial distribution, *Population dynamics, Lakes, Aquatic animals, Littoral environment, Eutrophication, Fish populations, Population density.

Zooplankton distribution in a small, eutrophic lake was studied over two seasons as part of a wider analysis of the fish-plankton interaction. Patchiness was evident at all sample spacings, but autocorrelation between adjacent samples became significant only at mean spacings of < 10 m. Patchiness could only rarely be correlated with environmental variables in open water, but there were consistent

trends in the distribution of most taxa with respect ot the shore. The limnetic assemblage within 10 m of the shore showed some littoral influence in the presence of littoral taxa and the relative paucity of euplankters. Emphasis is placed on the impact on plankton distribution of fish predation, which varies markedly in the study lake. (Author's abstract)
W89-05298

RESPIRATION IN EUTROPHIC LAKES: THE CONTRIBUTION OF BACTERIOPLANKTON AND BACTERIAL GROWTH YIELD,
Roskilde Universitetscenter (Denmark). Dept. of Biology and Chemistry.
T. Schwaerter, M. Sondergaard, B. Riemann, and L. M. Jensen.
Journal of Plankton Research JPLRD9, Vol. 10, No. 3, p 515-531, May 1988. 9 fig, 2 tab, 47 ref. Danish Natural Science Research Council 11-1816 and 11-4758.

Descriptors: *Bacteria, *Growth kinetics, *Limnology, *Eutrophic lakes, *Population dynamics, *Respiration, *Oxygen uptake, *Phytoplankton, Denmark, Seasonal variation, Cycling nutrients, Lakes, Biochemistry, Bacterial physiology, Metabolism, Oxygen balance.

The contribution of bacterioplankton to total plankton respiration was measured in two eutrophic Danish lakes and in experimental enclosures treated with planktivorous fish and nutrients. Bacterial respiration was calculated from measured oxygen uptake rates in particles passing a 1.0 micron pore size filter, the rates were then corrected for the size distribution of glucose uptake. During summer, the respiration of the planktonic bacteria contributed about 50% of the community respiration in the two lakes. Prolific phytoplankton growth induced by biomanipulation and nutrient addition created situations where the contribution of the bacteria decreased to 20%. High bacterial contributions to community respiration were found when the phytoplankton biomass decreased. Simultaneous measurements of bacterial respiration and production (by means of (H3)thymidine incorporation) allowed an estimation of bacterial growth yield, which ranged from 9 to 66%. In the two lakes, the growth yield was constant with a mean of 29 plus of minus 5% (plus or minus standard deviation, respiratory quotient = 1). The variability of the growth yield was larger in the enclosures. The wide range (9-66%) was mainly caused by changes in bacterial net production without concomitant changes in respiration. The discussion includes an evaluation of the oxygen uptake method in size fractionated samples and the availability of labile organic substrates as a factor controlling bacterial growth yield. (Author's abstract)
W89-05299

IN SITU SURVIVAL OF PLASMID-BEARING AND PLASMIDLESS PSEUDOMONAS AERUGINOSA IN PRISTINE TROPICAL WATERS,
Puerto Rico Univ., Rio Piedras. Dept. of Biology.
N. E. Cruz-Cruz, G. A. Toranzos, D. G. Ahearn, and T. C. Hazen.
Applied and Environmental Microbiology AEMIDF, Vol. 54, No. 10, p 2574-2577, October 1988. 3 fig, 1 tab, 24 ref. NIH Grants RR-2657 and RR-8102, DOE Contract DE-AC09-76SR00001, and Water Resources Research Institute of the University of Puerto Rico at Mayaguez Sea Grant R/LR-08-87-THA1.

Descriptors: *Survival, *Tropical regions, *Fate of pollutants, *Risk assessment, *Limnology, *Genetic pollution, *Pseudomonas, *Aquatic habitats, *Adaptation, Bacteria, Microorganisms, Microenvironment, Ecosystems, Metabolism, Bacterial physiology.

To properly assess the risks of releasing genetically-engineered microorganisms into the environment, research needs to be performed on the survival, establishment, growth, and transfer of genetic information of model bacteria. Two rare wild-type strains of Pseudomonas aeruginosa were mixed in membrane diffusion chambers and then introduced into a natural freshwater environment for 72 h. The plamsid-containing strain (R serotype 15) and the plasmidless strain (H serotype 5) had initial bacterial densities of 200,000 cells/ml. Samples collected from the chambers were analyzed for viable and direct counts and for acquired-resistance frequencies. Suspected transconjugant-to-donor ratios ranged from 0.5 to 1.3; transfer percentages ranged from 13 to 70%. (H3)thymidine uptake indicated DNA synthesis in both strains as well as in transconjugants. These studies indicate that rare wild-type bacterial strains with large plasmid loads can survive as well as can bacteria with low plasmid loads when exposed to the in situ conditions of a tropical freshwater habitat. These results also suggest that genetic modification of indigenous microbiota through conjugation or transformation is feasible when rare wild-type strains or genetically engineered microorganisms are released in large numbers in tropical aquatic ecosystems. (Author's abstract)
W89-05305

EMISSION OF HYDROGEN FROM DEEP AND SHALLOW FRESHWATER ENVIRONMENTS,
Fraunhofer-Gesellschaft zur Foerderung der Angewandten Forschung e.V., Garmisch-Partenkirchen (Germany, F.R.). Inst. fuer Atmosphaerische Umweltforschung.
H. Schutz, R. Conrad, S. Goodwin, and W. Seiler.
Biogeochemistry, Vol. 5, No. 3, p 295-311, 1988. 4 fig, 5 tab, 49 ref.

Descriptors: *Limnology, *Water chemistry, *Bubbles, *Hydrogen, *Lake sediments, *Air-water interfaces, Photosynthesis, Aquatic environment, Chemical properties, Rice paddies.

In-situ partial pressures of hydrogen in anoxic profundal lake sediments reached values of up to 5 Pa which were more than 5 orders of magnitude lower than the partial pressures of methane. Analysis of gas bubbles collected from anoxic submerged paddy soil showed H2 partial pressures in the range of 1.8 + 1.3 Pa being 4 orders of magnitude lower than the CH4 partial pressures. H2 emission rates, on the other hand, were less than 3 orders of magnitude lower than the CH4 emission rates indicating that H2 and CH4 were oxidized to a different extent in the rhizosphere of the soil before they reached the atmosphere, or that H2 was produced by the plants. More than 70% of the emitted H2 reached the atmosphere via plant-mediated flux. The rest was emitted via ebullition from the anoxic soil and, in addition, was produced in the paddy water. A significant amount of H2 was, in fact, found to be produced in the water under conditions where thallic algae and submerged parts of the rice plants produced oxygen by photosynthesis. Very little H2 was emitted via molecular diffusion through the paddy water; in addition, this amount was less than expected from the degree of supersaturation and the diffusional emission rate of CH4 indicating a relatively high rate of H2 consumption in the surface film of the paddy water. The total H2 source strength of rice paddies and other freshwater environments was estimated to be less than 1 Tg/yr, being negligible in the atmospheric budget of H2. (Author's abstract)
W89-05323

TRANSPORT OF PHOSPHORUS, NITROGEN, AND CARBON BY THE APURE RIVER, VENEZUELA,
Colorado Univ. at Boulder. Dept. of Environmental, Population, and Organismic Biology.
J. F. Saunders, and W. M. Lewis.
Biogeochemistry, Vol. 5, No. 3, p 323-342, 1988. 5 fig, 5 tab, 39 ref. NSF Grants DEB 8116725, BSR 8315410.

Descriptors: *Nutrients, *Limnology, *Nitrogen, *Phosphorus, *Carbon, *Venezuela, *Tropical regions, *Apure River, Watersheds, Water cycle, Seasonal variation, Dissolved organic matter, River basins, Particulate matter, Water analysis, Nitrates, Flood plains.

The concentrations and transport of carbon, nitrogen, and phosphorus were studied in the Apure River, Venezuela, over a period of 21 months. The drainage basin encompasses 167,000 sq km, most of which has low relief and supports tropical savanna vegetation. Average runoff from the period of study was 361 mm/yr. Discharge-weighted mean concentrations were 188 micrograms/L for total P, 957 micrograms/L for total N, and 9.8 mg/L for organic C. Annual transport was 0.68 kg/ha/yr for total P, 3.45 kg/ha/yr for total N, and 35.4 kg/ha/yr for organic C. Particulate matter accounted for 68% of P, 54% of N, and 37% of C transport, agreeing well with empirical predictions, based mostly on the temperate zone, for watersheds of similar size and water yield. When the wet season begins, rising water flushes organic matter from side channels and produces a sharp increase in particulate C and N. Particulate P, which is associated more with mineral material, also increases during rising water. All dissolved constituents except inorganic C also increase over the rising-water phase. As the river inundates the floodplain, the concentration of nitrate declines, whereas the concentrations of dissolved organic C and N continue to rise. At high water, the floodplain appears to store sediments that are later remobilized. During low water, all fractions except dissolved inorganic C tend to be at minimum concentration. Soluble reactive P, total dissolved P, inorganic-, and organic C were successfully modeled as hyperbolic functions of discharge. No significant relationships were found between concentration and discharge for any particulate fraction because the flushing and storage mechanisms affecting these fractions occurred within specific hydrologic phases, rather than as a smooth function of discharge. No significant relationships were found for any nitrogen fraction. For nitrate, and thus for total dissolved N, of which nitrate is a major component, poor conformance to standard models is explained by association of key mechanisms (e.g. uptake) with specific hydrologic phases. Particulate components and nitrate in this sense violate the continuity assumptions implicit in the standard models. (Author's abstract)
W89-05324

MINERALIZATION OF N AND P ALONG A TROPHIC GRADIENT IN A FRESHWATER MIRE,
Utrecht Rijksuniversiteit (Netherlands). Dept. of Plant Ecology.
J. T. A. Verhoeven, A. M. Kooijman, and G. Van Wirdum.
Biogeochemistry, Vol. 6, No. 1, p 31-43, 1988. 2 fig, 4 tab, 22 ref.

Descriptors: *Limnology, *Mineralization, *Nitrogen, *Phosphorus, *Trophic level, *Wetlands, *Fens, *Peat bogs, Sampling, Percolation, Biomass, Chemical properties, Trophic zone, The Netherlands.

Release of inorganic nitrogen and phosphorus in the soil of a peatland (fen) in The Netherlands was measured by means of an in situ incubation technique. Three sampling stations were chosen along a gradient in the plant productivity and water chemistry of the fen. The station with the highest biomass production was located near the ditch that supplied the fen with water in amounts matching water losses through evaporation and downward percolation to the groundwater. Water chemistry at this station strongly resembled that of the ditch water. The two stations remote from the ditch had much lower plant biomass, and significantly lower pH conductivity, and calcium and bicarbonate concentrations. The vegetation at these two stations was characterized by a thick Sphagnum carpet. The release of inorganic N and P was much faster at the two stations remote from the ditch than at that located near the ditch. The differences in mineralization rate are probably due to the differences in water chemistry; phosphates are more soluble at low than at high pH. The fast N mineralization stations with a thick Sphagnum carpet may be related to the chemical composition of Sphagnum litter. The difference in productivity is not explained by the N and P mineralization rates. Direct supply of N and P from the ditch are probably the main cause of the high productivity at the station bordering the ditch. (Author's abstract)

W89-05325

DIFFERENTIATION OF SOME VENEZUELAN BLACKWATER RIVERS BASED UPON PHYSICO-CHEMICAL PROPERTIES OF THEIR HUMIC SUBSTANCES,
Instituto Venezolano de Investigaciones Cientificas, Caracas. Centro de Ecologia y Ciencias Ambientales.
For primary bibliographic entry see Field 2E.
W89-05326

NEW METHOD OF DESCRIBING BOTTOM STRESS IN TWO-DIMENSIONAL HYDRODYNAMICAL MODELS OF SHALLOW HOMOGENEOUS SEAS, ESTUARIES, AND LAKES,
Western Australia Univ., Nedlands. Centre for Water Research.
C. J. Hearn, and J. R. Hunter.
Applied Mathematical Modelling AMMODL, Vol. 12, No. 6, p 573-580, December 1988. 1 fig, 22 ref.

Descriptors: *Stress, *Friction, *Hydrodynamics, *Model studies, *Bottom water, *Estuaries, *Lakes, Mathematical studies, Flow, Wind, Eddies, Water current, Viscosity, Physical properties, Rheology, Distribution, Vertical distribution.

A new expression for bottom friction is developed for use in two-dimensional hydrodynamical models of shallow homogeneous seas, estuaries, and lakes. Bottom stress is provided by a single relaxation approximation which can be used to replace the conventional parameterization in any existing explicit time-stepping model. The method produces the correct steady state flow for wind-driven circulation in shallow systems. It derives the bottom stress from the vertical eddy viscosity which can have any prescribed variation through the water column. The single relaxation approximation uses a recursive relation for bottom stress involving only values at the previous time step and a pair of precomputed coefficients at each grid point. (Author's abstract)
W89-05347

STAGE FLUCTUATIONS OF WISCONSIN LAKES,
Geological Survey, Madison, WI. Water Resources Div.
L. B. House.
Wisconsin Geological and Natural History Survey Information Circular Number 49, March 1985. 84p, 9 fig, 2 tab, 2 ref, 2 append.

Descriptors: *Lake stages, *Limnology, *Hydrologic data collections, *Water level fluctuations, *Wisconsin, Classification, Groundwater movement, Surface waters, Seasonal variation.

Lake-stage fluctuations of 83 gaged lakes in Wisconsin and techniques for estimating stage fluctuations at ungaged lakes are described. Included are stage information at 83 lakes and stage-frequency data for 32 of these lakes that had sufficient records for analysis. Lakes are classified by a hydrologic-topographic lake classification scheme as groundwater flow-through (GWF) lakes, surface-water drainage (SWD) lakes, and surface-water flow-through (SWF) lakes. Lakes within the same class were found to have similar water level fluctuations. The lake-stage records indicate that most annual maximums occur during the months of May and June for all three classes. Annual minimum lake levels generally occur in September for SWD lakes, in March for SWF lakes, and in November for GWF lakes. Stage frequency analysis was performed for 32 lakes that have long-term records. Analysis includes maximum and minimum stage estimates for the 2-, 5-, 10-, 20-, 50-, and 100-year recurrence intervals. Estimates of the annual stage fluctuation for the same recurrence intervals also are provided. An analysis of stage fluctuation-probability curves for each lake class show that there is a 50% probability that a SWF lake's average annual stage fluctuation will exceed 1.5 ft, GWF lakes will exceed 1.1 ft, and SWD lakes will exceed 0.8 ft. (Lantz-PTT)

W89-05390

IMPACT OF PHOSPHORUS REDUCTION VIA METALIMNETIC ALUM INJECTION IN BULLHEAD LAKE, WISCONSIN,
Geological Survey, Madison, WI. Water Resources Div.
For primary bibliographic entry see Field 5G.
W89-05393

TROPHIC CLASSIFICATION OF WASHINGTON LAKES USING RECONNAISSANCE DATA,
Geological Survey, Tacoma, WA. Water Resources Div.
S. S. Sumioka, and N. P. Dion.
Washington Department of Ecology Water-Supply Bulletin 57, 1985. 320p, 2 tab, 37 ref, 3 append.

Descriptors: *Limnology, *Hydrologic data collections, *Trophic level, *Washington, *Lakes, Water quality, Nitrogen, Chlorophyll a, Phosphorus, Eutrophication, Transparency.

A total of 134 Washington lakes were sampled to obtain information on their physical, cultural and water quality conditions. Each lake was classified by trophic level using two methods: (1) a relative, multivariate technique based on Secchi-disc transparency and concentrations of total phosphorus, total organic nitrogen, and chlorophyll a in the epilimnion; and (2) an absolute, univariate technique based on any one of three water quality parameters: Secchi-disc transparency, total phosphorus concentration, or chlorophyll a concentration. The first method yielded a characteristic value (CV) for each lake with a range of 45 to 1,047 and median of 119, for the 134 lakes visited. The second method yielded trophic state index (TSI) values ranging from 30 to 67, 0 to 108, and 0 to 74, with medians of 44, 47, and 44 when based on Secchi disk transparency, total phosphorus, and chlorophyll a, respectively. In both methods, the degree of eutrophication increases as the numeric value increases. The lake rankings produced by the two methods were in general agreement, in that lakes were placed in about the same relative position using either system. Characteristic values and TSI's were also calculated for all lakes in Washington for which adequate data exist. (Author's abstract)
W89-05394

HYDROLOGY AND WATER QUALITY OF DELAVAN LAKE IN SOUTHEASTERN WISCONSIN,
Geological Survey, Madison, WI. Water Resources Div.
For primary bibliographic entry see Field 5B.
W89-05424

NATIONAL SURFACE WATER SURVEY, WESTERN LAKE SURVEY (PHASE 1 - SYNOPTIC CHEMISTRY) QUALITY ASSURANCE REPORT,
Lockheed Engineering and Management Services Co., Inc., Las Vegas, NV.
For primary bibliographic entry see Field 7A.
W89-05513

ECOSYSTEM ANALYSIS OF THE CALCASIEU RIVER/LAKE COMPLEX (CALECO).
McNeese State Univ., Lake Charles, LA.
For primary bibliographic entry see Field 4C.
W89-05529

SPECIAL POLLUTANTS,
McNeese State Univ., Lake Charles, LA. Dept. of Biological and Environmental Sciences.
For primary bibliographic entry see Field 5B.
W89-05531

VEGETATION OF INLAND WATERS.
Kluwer Academic Publishers, Boston, MA. Handbook of Vegetation Science Series Vol. 15/1. 1988. 385p. Edited by J. J. Symoens.

Descriptors: *Aquatic plants, *Aquatic vegetation, *Vegetation, *Vegetation effects, *Limnology, Plant growth, Plant populations, Plant physiology, Flora, Algae, Aquatic weeds.

In spite of the huge extent of water ecosystems, aquaculture has lagged far behind agriculture and is a relatively limited source of human food on a worldwide scale. Although the general principles of ecology and biocenotics are common to both aquatic and terrestrial communities, the water environment is less accessible to the observer's eye, and it requires specialized methods and equipment of investigation as soon as the depth goes beyond a few centimeters. Water, due to its high density, is a very favorable medium for sustaining plants. Submersed plants have no need to develop a large mechanical structure to provide support and can concentrate their activity in the development of productive chlorophyll-containing cells. In the aquatic habitat where many macrophytes and most microphytes are not bound to the soil, the plants may be transported by water currents and the assemblage present in any given water sample may consist of populations derived from different habitats and adapted to respond to substantially different sets of conditions. Two environmental factors peculiar to the aquatic medium play a decisive role in two types of water habitats: the highly variable hydrological regime in the flooded plains and the water current in the fluviatile habitats. (See W89-05544 thru W89-05554) (White-Reimer-PTT)
W89-05543

WATER AS AN ENVIRONMENT FOR PLANT LIFE,
Michigan Univ., Ann Arbor. Div. of Biological Sciences.
R. G. Wetzel.
IN: Vegetation of Inland Waters. Kluwer Academic Publishers, Boston, MA. Handbook of Vegetation Science Series Vol. 15/1. 1988. p 1-30, 4 fig, 145 ref.

Descriptors: *Limnology, *Vegetation, *Plant growth, *Plant physiology, *Aquatic plants, *Flora, *Aquatic vegetation, Aquatic weeds, Light quality, Light intensity, Light penetration, Temperature, Hydrostatic pressure, Currents, Water turbulence, Sediments, Nutrients, Carbon cycle, Succession.

The immigration of terrestrial plants into the freshwater environment presented numerous physiological barriers. Although certain environmental parameters in water are more constant than in the terrestrial habitat, most conditions below water and in water-saturated sediments are acutely hostile to normal growth and reproductive characteristics of macrophytes. Extreme plasticity and adaptability is found among submersed macrophytes to the highly variable underwater light conditions. Because of the very high specific heat of liquid water, thermal conditions within standing waters change more slowly, are more stable, and permit a longer growing season than is commonly found in terrestrial aerial habitats. Hydrostatic pressure likely interacts with low light intensities to limit the distribution of submersed freshwater angiosperms to depths less than 10 meters. The surface of the water of lakes is a habitat subject to severe mechanical stresses from wind and water movements. Even though the sediments constitute an anaerobic environment that is hostile to normal plant metabolism, rooted aquatics are dependent on the sediments for nutrients. Rates of diffusion of gases in water are several orders of magnitude slower in water than in air. Due to interacting physical, chemical, and biological mechanisms that regulate autotrophic productivity in standing fresh waters, lake basins undergo succession and are ultimately obliterated as aquatic ecosystems and transformed into terrestrial ecosystems. (See also W89-05543) (White-Reimer-PTT)
W89-05544

METHODS OF EXPLORATION AND ANALYSIS OF THE ENVIRONMENT OF AQUATIC VEGETATION,
Station Biologique de la Tour du Valat, Arles

(France).
For primary bibliographic entry see Field 7B.
W89-05545

PHOTOSYNTHESIS OF AQUATIC PLANTS UNDER NATURAL CONDITIONS,
Roskilde Universitetscenter (Denmark). Inst. of Life Sciences and Chemistry.
M. Sondergaard.
IN: Vegetation of Inland Waters. Kluwer Academic Publishers, Boston, MA. Handbook of Vegetation Science Series Vol. 15/1. 1988. p 63-111, 4 tab, 11 fig, 200 ref.

Descriptors: *Photosynthesis, *Plant physiology, *Aquatic plants, *Aquatic productivity, *Carbon cycle, *Productivity, *Primary productivity, Carbonates, Carbon radioisotopes, Oxygen, Oxygen balance, Aquatic weeds, Alkalinity, Hydrogen ion concentration, Macrophytes.

Photosynthesis by the submerged vegetation in aquatic ecosystems is controlled by an array of variables changing in time and space. Each group of organisms have their special environmental requirements and physiological behavior. The measurement of photosynthesis in aquatic plants involves both methodological problems and questions on the interpretation regardless of methodology. The rate of photosynthesis of aquatic plants is controlled by two main factors: (1) The physiological state of the organisms themselves, and (2) abiotic and biotic factors in the environment. The most important sub-processes of photosynthesis are: (1) The uptake and reduction of CO2 and production of O2, (2) Photorespiration, (3) Dark respiration, and (4) Any extracellular loss of immediate photosynthetic products. The most direct and best method to measure photosynthetic activity is to measure the CO2 budget either directly or indirectly through pH and alkalinity. (See also W89-05543) (White-Reimer-PTT)
W89-05546

STRUCTURAL ASPECTS OF AQUATIC PLANT COMMUNITIES,
Katholieke Univ. Nijmegen (Netherlands). Lab. of Aquatic Ecology.
C. den Hartog, and G. van der Velde.
IN: Vegetation of Inland Waters. Kluwer Academic Publishers, Boston, MA. Handbook of Vegetation Science Series Vol. 15/1. 1988. p 113-154, 2 tab, 1 fig, 119 ref.

Descriptors: *Limnology, Aquatic vegetation, *Aquatic plants, *Plant populations, *Vegetation, *Community structure, Aquatic weeds, Flora, Macrophytes, Epiphytes, Plankton, Fauna, Phytoplankton.

A community is characterized by its species composition and by additional features derived of this, such as life-and growth-form spectra, diversity indices, and other components. The community structure consists of at least three major interrelated components: (1) Floristic and faunistic composition of the community, in a qualitative and quantitative sense. (2) The arrangement of the organisms in space and time. (3) The relations between the organisms within the community and their relations with the surrounding biotic and abiotic environment. For the understanding of the functioning of the aquatic plant communities knowledge of the structure is of paramount importance. Autecological and ecophysiological studies of the main dominant species, and studies on the interactions between the various community components are necessary. The pattern of the relationships between the various participants of a community can only be studied in the form of well-planned case studies, which have to be projected against the background of the whole community. (See also W89-05543) (White-Reimer-PTT)
W89-05547

PHYTOSOCIOLOGICAL APPROACH TO THE DESCRIPTION AND CLASSIFICATION OF AQUATIC MACROPHYTIC VEGETATION,
Centre for Agrobiological Research, Wageningen (Netherlands).
E. P. H. Best.
IN: Vegetation of Inland Waters. Kluwer Academic Publishers, Boston, MA. Handbook of Vegetation Science Series Vol. 15/1. 1988. p 155-182, 8 tab, 5 fig, 77 ref.

Descriptors: *Community structure, *Aquatic vegetation, *Vegetation, *Aquatic plants, *Aquatic weeds, *Plant populations, *Flora, *Macrophytes, *Phytosociology, Classification.

Aquatic vegetation can be characterized in various ways and for various purposes. A vegetation can be defined as a characteristic collection of individual plants in connection with their growth site which exhibits a structure that changes in space and time, due to selection by dispersal potential, physico-chemical requirements and biological interactions. Vegetation analysis can be used to describe aquatic plant communities in a manner which provides more information than only lists of species, such as succession patterns and anthropogenic stress on aquatic ecosystems. Vegetation analysis should not be limited to a mere description of structures because extrapolation to unknown areas is difficult. It should be aimed at understanding the structure and function of vegetation and therefore use taxonomical as well as functional criteria. The methods and notions used for describing aquatic vegetations should be similar to those used for terrestrial vegetations. (See also W89-05543) (White-Reimer-PTT)
W89-05548

ALGAL COMMUNITIES OF CONTINENTAL WATERS,
Vrije Univ., Brussels (Belgium). Lab. voor Algemene Plantkunde en Natuurbeheer.
J. J. Symoens, E. Kusel-Fetzmann, and J. P. Descy.
IN: Vegetation of Inland Waters. Kluwer Academic Publishers, Boston, MA. Handbook of Vegetation Science Series Vol. 15/1. 1988. p 183-222, 3 fig, 209 ref.

Descriptors: *Aquatic plants, *Limnology, *Aquatic vegetation, *Algae, *Phytoplankton, *Plant populations, Indicators, Water quality, Taxonomy.

The integration of the algae into a syntaxonomical system is obvious only in two cases: where the vegetation consists exclusively of algae, and where the size of the algae is comparable to that of the higher plants which they accompany. In most aquatic habitats, temporal changes represent a universal characteristic of algal populations. The factors responsible for these changes are many and complex: temperature, light, turbulence, inorganic nutrients, organic materials, grazing, parasitism. Methods of analyzing algal sociology include: identification and assessment of abundance, use of character-species or dominant species, and assessment of species association by multivariate analysis. The biological assessment of water quality based on algal communities often relies on the presence or absence of certain species or assemblages. However, the indicator species concept has two faults: (1) the presence-absence criterion is too simple, as it does not consider the degree of abundance or vitality of the species within their ecological range, and (2) different species may have very different indicator-values. The development of general systems of water quality monitoring based on algae requires, as for other taxocenes, a reference system which should be obtained by the study of natural communities. (See also W89-05543) (White-Reimer-PTT)
W89-05549

VEGETATION PROCESSES IN SWAMPS AND FLOODED PLAINS,
Natal Univ., Pietermaritzburg (South Africa). Inst. of Natural Resources.
C. M. Breen, K. H. Rogers, and P. J. Ashton.
IN: Vegetation of Inland Waters. Kluwer Academic Publishers, Boston, MA. Handbook of Vegetation Science Series Vol. 15/1. 1988. p 223-248, 104 ref.

Descriptors: *Aquatic vegetation, *Limnology, *Swamps, *Marshes, *Wetlands, *Flood plains, *Aquatic plants, Vegetation, Flora, Plant populations, Species diversity.

The permanently inundated hydrological conditions that characterize swamps favor the establishment of those species possessing life history characteristics which enable biotic isolating mechanisms to dominate the community structure. Ultimately, the community has a low species diversity and species composition remains relatively stable and homogeneous. In contrast, the disruptive effects of the variable hydrological regime found on most flooded plains restricts the development of biotic isolating mechanisms, thus allowing transporting mechanisms to dominate. Species diversity can be low but species composition changes rapidly in response to irregularities in the hydrological regime and the communities are spatially heterogeneous. Ultimately, swamps and flooded plains can be seen in terms of different combinations of isolating and transporting mechanisms and as occupying two extremes of a hydrological gradient. However, the structure and functioning of these respective ecosystems is largely dependent on the physical presence of plants and their population dynamics and metabolism. (See also W89-05543) (White-Reimer-PTT)
W89-05550

VEGETATION OF FENS IN RELATION TO THEIR HYDROLOGY AND NUTRIENT DYNAMICS: A CASE STUDY,
Utrecht Rijksuniversiteit (Netherlands). Dept. of Plant Ecology.
For primary bibliographic entry see Field 5C.
W89-05551

WATER FLOW AND THE VEGETATION OF RUNNING WATERS,
Freshwater Biological Association, Wareham (England). River Lab.
F. H. Dawson.
IN: Vegetation of Inland Waters. Kluwer Academic Publishers, Boston, MA. Handbook of Vegetation Science Series Vol. 15/1. 1988. p 283-309, 3 tab, 2 fig, 105 ref.

Descriptors: *Aquatic vegetation, *Streamflow, *Water currents, *Vegetation, *Aquatic plants, *Flora, *Plant populations, Plant growth, Flow discharge, Running waters, Rivers, Streams.

The vegetation of running waters is defined and determined by the effect and interactions of a single physical factor, water flow, which governs plant-form, dominates the growth-controlling factors and defines the habitat. Between the extremes of high and low flows, the physical and chemical factors can control growth, interact with fluviatile plants to regulate seasonal biomass and to create flowing water communities. Such communities can vary during the year influenced either by seasonal changes in their physical environment, or by competition between species. The plant community at a site therefore reflects the balance achieved between the physicochemical environment and the plants tolerance, adaption to or their modification of these conditions by their presence. Plants, despite belonging to many taxonomic groups, respond to environmental forces or selection to produce a common simplicity or uniformity of form between members of different taxa in particular habitats when strongly influenced by environmental variables, particularly water flow. (See also W89-05543) (White-Reimer-PTT)
W89-05552

AQUATIC PLANTS IN EXTREME ENVIRONMENTS,
California Univ., Santa Barbara. Dept. of Biological Sciences.
J. M. Melack.
IN: Vegetation of Inland Waters. Kluwer Academic Publishers, Boston, MA. Handbook of Vegetation Science Series Vol. 15/1. 1988. p 341-378, 3 tab, 325 ref.

Descriptors: *Aquatic vegetation, *Vegetation, *Aquatic plants, *Flora, *Plant populations,

*Algae, *Macrophytes, Habitats, Environment, Environmental extremes, Temperature, Lakes, Saline water, Alkaline water, Species diversity.

The ecology of aquatic plants that inhabit physically and chemically extreme environments of inland waters is reviewed. The material presented is circumscribed by criteria that delineate the taxa, the habitats, and the environmental conditions. The pool of organisms studied represents seven divisions of plants, and the environmental bounds selected are near those tolerated by actively growing and reproducing plants and sufficiently severe to restrict the flora to very few species. In hypersaline waters the number of species of phytoplankton is low and decreases as salinity increases, cyanobacterial mats are common in shallow areas, and very few taxa of angiosperms and no bryophytes grow and reproduce. In alkaline, saline lakes no submerged angiosperms or macroalgae occur, and the phytoplankton and benthic mats are primarily cyanobacteria, diatoms, and chlorophytes. Waters with temperatures exceeding 50 C have a greatly reduced number of species consisting only of prokaryotes (up to 60-62 C) and photosynthetic cyanobacteria (up to c. 73 C). Cryophytic algae are the primary producers in low temperature waters. (See also W89-05543) (White-Reimer-PTT)
W89-05554

LIMNOLOGY OF WEST POINT RESERVOIR, GEORGIA AND ALABAMA,
D. B. Radtke.
IN: Selected Papers in the Hydrologic Sciences 1986. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Supply Paper 2290. 1986. p 1-16, 11 fig, 1 tab, 9 ref.

Descriptors: *West Point Reservoir, *Georgia, *Alabama, *Limnology, *Eutrophication, *Oxygen deficit, *Nutrients, Manganese, Iron, Phosphorus, Nitrogen, Organic carbon, Chattahoochee River, Algae, Fish, Polychlorinated biphenyls, Chlordane, Sediments, Tissue analysis.

Water-quality, bottom-sediment, and fish-tissue samples were collected from West Point Reservoir on the Chattahoochee River to determine whether water-quality problems had occurred subsequent to impoundment. Severe hypolimnetic oxygen deficiency occurred in the reservoir following thermal stratification in the spring of 1978 and 1979. During stratified periods, concentrations of dissolve Fe and Mn in the hypolimnion at the dam pool ranged from 0-7700 and 30-2000 micrograms, respectively. During thermally stratified periods, phytoplankton standing crops in the upper lentic section of the reservoir ranged from 39,000 to 670,000 cells/ml. A maximum algal growth potential value (USGS method) of 48.0 mg/l was obtained at the uppermost data collection station. The primary growth-limiting nutrients were N in the lotic section and P in the lentic section. The highest measured concentrations of volatile solids and total Fe, Mn, P, and organic C in sediments occurred in the lentic section of the reservoir, where bottom sediments consist mainly of silt and clay. Polychlorinated biphenyls and chlordane concentrations in the bottom sediments were as high as 740 and 210 micrograms/kg, respectively. Concentrations of polychlorinated biphenyls and chlordane in fish tissue ranged from 19 to 3800 and 6.0 to 280 micrograms/kg, respectively. (See also W89-05586) (Author's abstract)
W89-05587

RESERVOIRS: LEAKAGE FROM RESERVOIRS,
L. B. James.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 722-729, 748-749, 5 fig, 33 ref.

Descriptors: *Reservoirs, *Leakage, *Bank storage, *Safety, *Economic aspects, Pipe flow, Project planning, Reservoir operation, Grouting, Cutoffs, Reservoir linings, Geologic formations, Underflow, Specific retention, Maintenance.

Leakage, a condition that can prove both hazardous and costly, is undesirable at most reservoirs. Piping, the transporting of soil particles to unprotected exits in the perimeter of a reservoir, is the most serious condition that can be caused by leakage. Avoidance or prevention of leakage is more easily accomplished during the planning and construction stages of a project than after a reservoir is placed in operation. Repair of reservoirs that have developed localized leakage usually is attempted by installation of grout curtains, positive cutoff walls, upstream blankets, or weighted protective filters at downstream exits. The characteristics of four distinct types of rock--carbonate rocks, evaporite deposits, unconsolidated sedimentary formations, and volcanic rocks--are discussed as they affect leakage from reservoir sites. Where construction of a dam will cut off underflow, which in the past has recharged downstream groundwater resources, provision for an equivalent substitute supply usually will be required. Where the levels in a reservoir fluctuate, as happens in almost all instances, some of the water that seeps into the banks at a high stage is returned to the pool when the level recedes. The volume of water required to satisfy the specific retention of the walls of a reservoir represents a permanent loss, except to the extent that it may usefully feed the roots of vegetation. (See also W89-05687) (Shidler-PTT)
W89-05742

RESERVOIRS: RESERVOIR PROBLEMS OTHER THAN LEAKAGE,
Kiersch Associates, Inc., Tucson, AZ.
G. A. Kiersch.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 729-750, 14 fig, 1 tab, 43 ref.

Descriptors: *Reservoirs, *Slope stability, *Reservoir silting, *Flooding, *Seismology, Landslides, Sheet erosion, Gully erosion, Mass wasting, Mudflows, Waves, Avalanches, Lake ice, Reviews.

The common reservoir problems of slope instability throughout the banks and perimeter, silting and sedimentation deposits within the basin, flooding due to failure of natural dams upstream, and related aspects are reviewed. A constant concern of the dam designer, constructor, and operator is the possible movement of a large rock and soil mass into the reservoir. Sheet erosion, gullying, associated mass-wasting processes, and mudflows caused by running water can be a major source of reservoir sediment in some regions; the principal factors are climate, geological setting and properties of surficial soil and rock types. Sediment is an economic liability; the total damage from its accumulation in streams and reservoirs/lakes can be billions of dollars annually. There has been a long history of landslide and/or rockfall disasters that have generated large waves and inundated the shorelines of reservoirs and lakes, with catastrophic loss of life and property. The damming of rivers by slide, debris, or avalanche flows, or their rapid accumulations in a reservoir/lake can be a significant hazard. Many cases of landslide-dammed lakes and streams have been reported throughout the world. Backflooding, seismicity induced by reservoir loading, induced aseismicity, and surface ice accumulations are also summarized. (See also W89-05687) (Shidler-PTT)
W89-05743

INPUT-OUTPUT MASS LOADING STUDIES OF TOXIC AND CONVENTIONAL POLLUTANTS IN TRENTON CHANNEL, DETROIT RIVER: ACTIVITIES C.1 AND F.5 IN THE UPPER GREAT LAKES CONNECTING CHANNELS STUDY (UGLCCS).
Environmental Research Lab.-Duluth, Grosse Ile, MI. Large Lakes Research Station.
For primary bibliographic entry see Field 5B.
W89-05761

OUR NATIONAL HERITAGE: A PROTECTION GUIDEBOOK,
For primary bibliographic entry see Field 6E.
W89-05770

2I. Water In Plants

MODELLING FOREST WATER CONSUMPTION IN THE NETHERLANDS,
Groningen Rijksuniversiteit (Netherlands). Dept. of Physical Geography.
For primary bibliographic entry see Field 2D.
W89-05146

HYDROLOGY OF THE WETLAND NAARDERMEER: INFLUENCE OF THE SURROUNDING AREA AND IMPACT ON VEGETATION,
Utrecht Rijksuniversiteit (Netherlands). Dept. of Environmental Studies.
For primary bibliographic entry see Field 2H.
W89-05150

CRITICAL CONCENTRATIONS OF TISSUE NITROGEN AND PHOSPHORUS FOR GROWTH RATE AND YIELD IN THE FRESHWATER BLUE-GREEN ALGA MICROCYSTIS AERUGINOSA KUTZ. IN THE TROPICS,
Asian Inst. of Tech., Bangkok (Thailand).
J. A. Colman, and C. R. Santha.
Aquatic Botany AQBODS, Vol. 32, No. 1-2, p 167-177, October 1988. 2 fig, 3 tab, 18 ref.

Descriptors: *Aquaculture, *Algae, *Cyanophyta, *Tissue analysis, *Microcystis, *Nutrient requirements, Nitrogen, Phosphorus, Tropical regions, Plant tissues, Growth rate, Aquaculture.

Critical concentrations of tissue nitrogen and phosphorus for growth rate and yield in the freshwater blue-green alga Microcystis aeruginosa Kutz. were investigated to facilitate its production in aquaculture ponds. Growth-curve and yield experiments in flask cultures of Microcystis confirmed earlier predictions of reductions in assessed yield-derived critical concentrations caused by culture-ageing effects. Yield-derived critical levels for 90% saturated response were 4.1% N and 0.28% P. A derivation which assumed a Droop equation parameterization of growth enabled conversion of the yield-derived values to growth-rate critical concentrations. For 90% saturated growth rate these were $N < or = 5.4\%$ and $P < or = 0.42\%$. Field and culture pond measurements commonly found in excess of these values and the well-known ability of algae to remove nutrients from water indicate that fertilizer applications sufficient to maintain tissue levels in excess of the critical levels would be an efficient strategy for maximum Microcystis production in culture ponds. (Author's abstract)
W89-05260

VEGETATION OF INLAND WATERS.
For primary bibliographic entry see Field 2H.
W89-05543

METHODS OF EXPLORATION AND ANALYSIS OF THE ENVIRONMENT OF AQUATIC VEGETATION,
Station Biologique de la Tour du Valat, Arles (France).
For primary bibliographic entry see Field 7B.
W89-05545

PHOTOSYNTHESIS OF AQUATIC PLANTS UNDER NATURAL CONDITIONS,
Roskilde Universitetscenter (Denmark). Inst. of Life Sciences and Chemistry.
For primary bibliographic entry see Field 2H.
W89-05546

STRUCTURAL ASPECTS OF AQUATIC PLANT COMMUNITIES,
Katholieke Univ. Nijmegen (Netherlands). Lab. of Aquatic Ecology.
For primary bibliographic entry see Field 2H.
W89-05547

PHYTOSOCIOLOGICAL APPROACH TO THE DESCRIPTION AND CLASSIFICATION OF AQUATIC MACROPHYTIC VEGETATION,
Centre for Agrobiological Research, Wageningen (Netherlands).
For primary bibliographic entry see Field 2H.
W89-05548

ALGAL COMMUNITIES OF CONTINENTAL WATERS,
Vrije Univ., Brussels (Belgium). Lab. voor Algemene Plantkunde en Natuurbeheer.
For primary bibliographic entry see Field 2H.
W89-05549

WATER FLOW AND THE VEGETATION OF RUNNING WATERS,
Freshwater Biological Association, Wareham (England). River Lab.
For primary bibliographic entry see Field 2H.
W89-05552

ANALYSIS OF FLORA AND VEGETATION IN RIVERS: CONCEPTS AND APPLICATIONS,
Oldenburg Univ. (Germany, F.R.). Dept. of Biology.
For primary bibliographic entry see Field 2E.
W89-05553

AQUATIC PLANTS IN EXTREME ENVIRONMENTS,
California Univ., Santa Barbara. Dept. of Biological Sciences.
For primary bibliographic entry see Field 2H.
W89-05554

2J. Erosion and Sedimentation

MINERALOGICAL AND OXYGEN-ISOTOPE STUDIES OF CLASTIC DIAGENESIS: IMPLICATIONS FOR FLUID FLOW IN SEDIMENTARY BASINS,
University of Western Ontario, London. Dept. of Geology.
For primary bibliographic entry see Field 2F.
W89-04581

ENVIRONMENTAL ASPECTS OF PEAT SILTATION ARISING FROM INTENSIVE PEATLAND EXPLOITATION IN IRELAND,
Irish Peat Development Authority, Dublin. Civil Engineering Div.
For primary bibliographic entry see Field 4C.
W89-04724

SEDIMENTATION IN LAKE PALOJARVI, NORTHERN KARELIA, THE OLDEST RESERVOIR IN FINLAND,
Joensuu Univ. (Finland). Dept. of Geography.
For primary bibliographic entry see Field 2H.
W89-04728

SEDIMENTATION IN LAKE TUSCALOOSA, ALABAMA, 1982-86,
Geological Survey, Tuscaloosa, AL. Water Resources Div.
L. J. Slack, and J. L. Pritchett.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 87-4256, 1988. 24p, 18 fig, 1 tab, 9 ref.

Descriptors: *Silting, *Sedimentation, *Reservoirs, *Alabama, Water supply, Sedimentation rate, Deposition, River basins, Slopes, Scour, Sediment distribution.

Lake Tuscaloosa, created in 1969 by the impoundment of North River, provides the primary water supply for Tuscaloosa, Alabama, and surrounding areas. This report describes the rate of sedimentation in the lake from its principal tributaries. The rate of sediment deposition in the lake is low. The maximum sediment deposition from 1982 to 1986 at 17 lake cross sections was about 3.5 feet (or 0.9 foot per year) at a cross section that received drainage from Brush Creek basin. Brush Creek is an unmined basin with steep overland and channel slopes. At 15 of the 17 cross sections, the maximum sediment deposition was less than 2 feet (or 0.5 foot per year). Scour and fill processes (redistribution of the sediment) appear to be taking place at many of the cross sections. (Author's abstract)
W89-04900

SEDIMENTATION AND WATER QUALITY IN THE WEST BRANCH SHADE RIVER BASIN, OHIO, 1983-85,
Geological Survey, Columbus, OH. Water Resources Div.
For primary bibliographic entry see Field 5B.
W89-04901

COMPUTER PROGRAMS FOR COMPUTING PARTICLE-SIZE STATISTICS OF FLUVIAL SEDIMENTS,
Geological Survey, Denver, CO. Water Resources Div.
For primary bibliographic entry see Field 7C.
W89-04921

COMPARISON OF FLUME AND TOWING METHODS FOR VERIFYING THE CALIBRATION OF A SUSPENDED-SEDIMENT SAMPLER,
Geological Survey, Minneapolis, MN. Water Resources Div.
For primary bibliographic entry see Field 7B.
W89-04956

STREAM-VARIABLE RESPONSE TO A CHANGE IN SURFICIAL GEOLOGY: MIDDLE FORK, BIG WALNUT CREEK, HENDRICKS COUNTY, INDIANA,
Indiana Univ.-Purdue Univ. at Indianapolis. Dept. of Geology.
P. K. Doss, D. E. Grow, and R. D. Hall.
Proceedings of the Indiana Academy of Science PIACAP, Vol. 96, p 333-343, 1986. 12 fig, 1 tab, 10 ref.

Descriptors: *Streams, *Channel morphology, Geomorphology, *Sediment grading, *Geology, *Indiana, Streamflow, Equilibrium, Surficial geology, Surface water, Big Walnut Creek.

The Middle Fork of Walnut Creek flows across a contact between Wisconsinan glaciolacustrine sediments (upstream) and outwash (downstream) in northwestern Hendricks County, Indiana. Preliminary field investigations suggested that corresponding changes occur in the geometry of the channel cross sections in this area. Fourteen stations were established in March 1985 to determine: (1) if this reach of Big Walnut Creek is in equilibrium with its geologic setting, and (2) how sediment and stream-channel characteristics reflect a difference in the geology of the surficial materials along the study reach of the stream. At each station, water-surface elevation and cross-section geometry were determined and suspended sediment and bed material were sampled. The responses of particular stream variables to internal and external factors are well observed along the study reach of Big Walnut Creek. An increase in grain size of the surficial materials surrounding the stream occurs between stations G and H. This change in surficial materials results in distinct changes in channel shape and velocity in order to provide the energy to transport the coarser load, and at the same time permit the stream to maintain a constant slope of the water surface. The response of specific internal variables to changing lithologic controls maintains the dynamic equilibrium of the system. (Miller-PTT)
W89-05004

ISOTOPIC CHARACTERIZATION OF LAKE KIZAKI AND LAKE SUWA,
Mitsubishi-Kasei Inst. of Life Sciences, Tokyo (Japan). Lab. of Biogeochemistry and Sociogeochemistry.
T. Yoshioka, E. Wada, and Y. Saijo.
Japanese Journal of Limnology RIZAA, Vol. 49, No. 2, p 119-128, April 1988. 5 fig, 3 tab, 33 ref. Ministry of Education, Science and Culture of Japan Grant 60129034.

Descriptors: *Limnology, *Eutrophication, *Isotope studies, *Lake sediments, *Sedimentation, *Carbon, *Nitrogen, Ecosystems, Denitrification, Japan, Indicators, Lakes, Microcytis, Nitrogen cycle.

Carbon and nitrogen isotope ratios in sedimentary organics and N15/N14 ratio of NO3(-) and dissolved organic nitrogen are reported for two subalpine lakes in order to establish an isotopical and biogeochemical framework characterizing lake ecosystems. A two-source organic model is applicable to evaluate the contribution of land-derived organics to the sedimentary organic matters of Lake Kizaki. A kind of chromatographic sedimentation of the land-derived particles with different specific gravity was suggested from the river mouth to the mid-lake. The size distributions of the isotope ratios support this inference. Denitrification and the associated oxidation-reduction reaction seemed to enhance the N15 content of sedimentary organics during epidiagenesis of the sedimentary organic matters. The isotopic compositions of the sedimentary organics and the soluble nitrogenous compounds can be useful indicators to characterize a biogeochemical structure of a lake system. Significant increase in C13/C12 ration of sedimentary organics by 3 ppt and in N15/N14 ratio of NO3(-) and dissolved organic nitrogen by 2 to 7 ppt were found under eutrophication caused by human impact in the highly eutrophic lake, Lake Suwa. External loading of nutrient salts by human activities and its associated heavy water bloom of Microcystis are responsible for these phenomena. (Author's abstract)
W89-05073

SEDIMENT PH IN PROFUNDAL CORE SAMPLES FROM THE TURKEY LAKES (ALGOMA, ONTARIO),
Laurentian Univ., Sudbury (Ontario). Dept. of Biology.
For primary bibliographic entry see Field 5B.
W89-05099

EFFECT OF ACID PRECIPITATION ON MICROBIAL DECOMPOSITION PROCESSES IN SEDIMENT FROM STREAMS IN THE TURKEY LAKES WATERSHED,
Guelph Univ. (Ontario). Dept. of Environmental Biology.
For primary bibliographic entry see Field 5C.
W89-05100

LOADINGS OF ORGANOCHLORINE CONTAMINANTS AND TRACE ELEMENTS TO TWO ONTARIO LAKE SYSTEMS AND THEIR CONCENTRATIONS IN FISH,
Department of Fisheries and Oceans, Burlington (Ontario).
For primary bibliographic entry see Field 5B.
W89-05101

EFFECT OF DEFORESTATION ON ORGANIC DEBRIS DAMS,
Yale Univ., New Haven, CT. Dept. of Biology.
For primary bibliographic entry see Field 4C.
W89-05200

HYDRAULIC TEST OF STREAMER SEDIMENT TRAP,
Coastal Engineering Research Center, Vicksburg, MS.
For primary bibliographic entry see Field 7B.
W89-05217

SEDIMENT CHARACTERIZATION AND TRANSPORT IN COLUSA BASIN DRAIN,
Pahlavi Univ., Shiraz (Iran).
S. A. Mirbagheri, K. K. Tanji, and R. B. Krone.

Journal of Environmental Engineering JOEDDU, Vol. 114, No. 6, p 1257-1273, December 1988. 11 fig, 3 tab, 14 ref.

Descriptors: *Sediment yield, *Sediment transport, *Suspended sediments, *Open-channel drainage, Irrigation-return flow, Flow rates, California, Minerals, Algae, Organic matter.

Suspended sediment was studied in the lower reaches of the Colusa Basin Drain, California. Three categories of suspended sediment are mineral sediment, algae, and organic matter. Field data were used to develop functional relations and the rating curves between suspended sediment and parameters such as flow rates, current velocities, and depths. Physicochemical and biological factors controlling the transport, deposition, and resuspension of suspended sediment are discussed. Suspended sediment sampled from the drain is composed of about 30% organic matter, 10% suspended algae and 60% mineral sediment. (See also W89-05221) (Author's abstract)
W89-05220

SIMULATION OF SUSPENDED SEDIMENT IN COLUSA BASIN DRAIN,
Pahlavi Univ., Shiraz (Iran).
S. A. Mirbagheri, K. K. Tanji, and R. B. Krone.
Journal of Environmental Engineering JOEDDU, Vol. 114, No. 6, p 1275-1294, December 1988. 11 fig, 1 tab, 24 ref.

Descriptors: *Sediment transport, *Suspended sediments, *Computer models, *Model studies, *Simulation analysis, *Open-channel drainage, Model testing, Mathematical models, Finite difference methods, California.

Suspended sediment transport was simulated in the lower reaches of the Colusa Basin Drain, California. A one-dimensional dynamic mathematical and computer model was formulated to simulate suspended mineral sediment, suspended organic matter, and suspended algae. This computer model is based on the mass balance equation including advection transport, diffusion transport, deposition and erosion, chemical and biological transformations, and inflow of point and nonpoint sources. The mathematical solution was obtained by a finite difference implicit method. The model was calibrated and confirmed with the data collected from the Colusa Basin Drain. The simulated results are in good agreement with measured values. (See also W89-05220) (Author's abstract)
W89-05221

SUSPENDED SOLIDS REMOVAL IN DETENTION BASINS,
Syracuse Univ., NY. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W89-05224

LOCAL SCOUR AROUND CYLINDRICAL OBJECTS,
City Coll., New York. Dept. of Civil Engineering.
R. M. Khanbilvardi, M. W. Akhtar, and A. S. Rogowski.
Water Resources Bulletin WARBAQ, Vol. 24, No. 4, p 839-845, August 1988. 12 fig, 4 tab, 16 ref.

Descriptors: *Scour, *Channel erosion, *Hydrodynamics, *Flow characteristics, *Flow around objects, *Mathematical analysis, Erosion, Channel flow, Predictions, Comparison studies.

Several predictors for the maximum local scour around cylindrical objects were compared to available experimental data. The range of flow parameters for which these formulas are valid are presented. It was found that most predictors overpredicted the measured values, and that the best predictor among those compared in this study was the scour formula by Jain (1981). A regression equation developed from experimental data appeared to give better fit than other formulas. Based on the available data, a formula for estimating local scour around cylindrical objects is given. (Author's abstract)
W89-05274

WATER ACIDIFICATION BY ADDITION OF AMMONIUM SULFATE IN SEDIMENT-WATER COLUMNS AND IN NATURAL WATERS,
Katholieke Univ. Nijmegen (Netherlands). Lab. of Aquatic Ecology.
For primary bibliographic entry see Field 5B.
W89-05290

ASSOCIATIONS BETWEEN STREAM VALLEY GEOMORPHOLOGY AND RIPARIAN VEGETATION AS A BASIS FOR LANDSCAPE ANALYSIS IN THE EASTERN SIERRA NEVADA, CALIFORNIA, USA,
Oregon State Univ., Corvallis. Dept. of Forest Science.
R. R. Harris.
Environmental Management EMNGDC, Vol. 12, No. 2, p 219-228, March 1988. 2 fig, 6 tab, 34 ref. NSF Grant BSR 8508356.

Descriptors: *Geomorphology, *Vegetation, *Riparian vegetation, *Riparian land, *Stream classification, *Geohydrology, Ecosystems, California, Valleys, Regimes, Bioindicators.

Ten streams in the eastern Sierra Nevada, California, were classified into six geomorphic valley types (U-shaped glaciated bedrock valley, V-shaped glaciated bedrock valley, U-shaped incised in till, V-shaped incised in till, alluvial fan, depositional flat behind moraines) and sampled to determine environmental and riparian vegetation conditions. The geomorphic valley types were relatively uniform geologically and hydrologically, collectively representing the range of stream environments in the region. Two-way indicator species analysis (TWINSPAN) was used to classify plots on the basis of plant species composition and species' relative cover. The vegetation types were defined as dominance types, emphasizing overstory trees and shrubs, which were felt to be responsive to large-scale geomorphic conditions. Associations between valley types and TWINSPAN vegetation types were then examined. There were significant associations between the geomorphic valley types and riparian community composition. These geomorphic-vegetation units are landscape elements that comprise the riparian ecosystems in the region. They differ in their ecological characteristics and sensitivity to management. The system of landscape elements can be used to classify streams for the purposes of resource inventory, detailed ecological studies, and impact prediction. (Author's abstract)
W89-05340

CHANNEL WIDENING CHARACTERISTICS AND BANK SLOPE DEVELOPMENT ALONG A REACH OF CANE CREEK, WEST TENNESSEE,
A. Simon, and C. R. Hupp.
IN: Selected Papers in the Hydrologic Sciences 1986. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Supply Paper 2290. 1986. p 113-126, 10 fig, 3 tab, 11 ref.

Descriptors: *Erosion, *Channel morphology, *Tennessee, *Channeling, *Bank erosion, *Dendrochronology, Cane Creek, Flood plains, Slough-line angle, Channel widening, Unstable channels, Stream banks.

Channelization and its related effects have led to 17 ft of degradation and 150 ft of widening of Cane Creek at Hunter Road from 1970 to 1983. The causes of widening are (1) overheightening of the loess channel banks beyond the critical bank height by incision and (2) deflection of flow towards the right bank, caused by entrapped trees from upstream bank failures, that resulted in severely scalloped banks on the outside bends of the high-flow thalweg. Tree-ring evidence and channel-geometry data indicate a minimum bank widening rate of about 4 ft/yr. Widening occurs predominantly by initial detachment from the bank by slab failure followed by deep-seated rotational failures of the upper banks. Piping and tension-crack development play important roles in these processes. Estimates of further channel widening over the next 10-20 yr range from 23 ft to approximately 60 ft. The slough-line angle, used as a measurement of temporary stability in the development of the reach's banks, is diagnostic in determining amounts of widening. The slough-line angle probably has flattened from the angle of internal friction (approximately 26 deg from the loess banks) to the present inclination (about 20 deg), and it should continue to flatten as Cane Creek develops a new flood plain at an elevation lower than its present one. (See also W89-05586) (Author's abstract)
W89-05596

IMPLICATIONS OF FLUME EXPERIMENTS FOR THE INTERPRETATION OF SLACK-WATER PALEOFLOOD SEDIMENTS,
Southern Illinois Univ. at Carbondale. Dept. of Geology.
For primary bibliographic entry see Field 2E.
W89-05641

SPILLWAY DESIGN AND CONSTRUCTION: SPECIAL DESIGN CONSIDERATIONS--ABRASION OF FLOW SURFACES,
For primary bibliographic entry see Field 8A.
W89-05726

SPILLWAY DESIGN AND CONSTRUCTION: SPECIAL DESIGN CONSIDERATIONS--CHANNEL EROSION,
For primary bibliographic entry see Field 8A.
W89-05727

WATER EROSION IN THE DRYLAND CROPPING REGIONS OF AUSTRALIA: 5. LAND AND LAND USE DATA FOR A RELATIVE ASSESSMENT OF POTENTIAL SOIL MOVEMENT IN WESTERN AUSTRALIA,
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
G. A. Yapp, and F. R. Gibbons.
Technical Memorandum 88/8, June 1988. 322p, 1 fig, 2 tab, 12 ref.

Descriptors: *Soil erosion, *Erosion, *Dry farming, *Australia, *Data collections, Land use, Cereal crops, Maps, Cropland, Soil properties, Slope degradation.

The dryland cropping region of Western Australia is divided into 13 Districts in a Sub-Regions. Each includes from one to six Local Government Areas (LGAs) according to comparative similarity of environmental and land use. Estimates are given for the proportion of each LGA in slope classes that are relevant to conservation oriented crop management practices. The principal cropping soils are allocated to these slope classes and the area cropped in a base period (1983-84) is allocated to these soils. The logic of the Universal Soil Loss Equation (USLE) is used to estimate the potential movement of soil from the area cropped in each soil x slope class in the standard period. Comments on the database are sought from individual experts in local and regional organizations. Further comments are sought on the values used for the factors in the USLE equation. The data are presented in sets of four tables for each LGA in the cereal cropping region. Location maps are provided to assist identification of the area under consideration. (Author's abstract)
W89-05758

FLOOD OF OCTOBER 1986 AT SEWARD, ALASKA,
Geological Survey, Anchorage, AK. Water Resources Div.
For primary bibliographic entry see Field 2E.
W89-05779

2K. Chemical Processes

PETROLEUM HYDROGEOLOGY: A HYDROGEOLOGICAL APPROACH TO PETROLEUM EXPLORATION AND BASIN ANALYSIS,

Port Harcourt Univ. (Nigeria). Dept. of Geology.
For primary bibliographic entry see Field 2F.
W89-04572

CHLORINE-36 DATING OF OLD GROUND WATER IN SEDIMENTARY BASINS,
New Mexico Inst. of Mining and Technology, Socorro. Dept. of Geoscience.
For primary bibliographic entry see Field 2F.
W89-04576

ORIGIN AND EVOLUTION OF WATER AND SOLUTES IN SEDIMENTARY BASINS,
Geological Survey, Menlo Park, CA.
For primary bibliographic entry see Field 2F.
W89-04579

SOLMNEQF: A COMPUTER CODE FOR GEOCHEMICAL MODELING OF WATER-ROCK INTERACTIONS IN SEDIMENTARY BASINS,
Battelle Project Management Div., Willowbrook, IL.
For primary bibliographic entry see Field 2F.
W89-04580

MINERALOGICAL AND OXYGEN-ISOTOPE STUDIES OF CLASTIC DIAGENESIS: IMPLICATIONS FOR FLUID FLOW IN SEDIMENTARY BASINS,
University of Western Ontario, London. Dept. of Geology.
For primary bibliographic entry see Field 2F.
W89-04581

MODELING OF OXYGEN ISOTOPES IN FORMATION WATERS - REVIEW OF THE PRINCIPLES WITH EXAMPLES,
For primary bibliographic entry see Field 2F.
W89-04582

COMPOSITION OF WATER IN WASTE WELL DISPOSAL FROM OIL SANDS AND HEAVY OIL FIELD PILOTS OF ALBERTA,
Alberta Research Council, Edmonton.
For primary bibliographic entry see Field 5E.
W89-04583

TIME-SERIES ANALYSIS OF EDWARDS AQUIFER SPRINGS IN COMAL COUNTY, TEXAS,
SRH Associates, Inc., Portland, OR.
For primary bibliographic entry see Field 2F.
W89-04592

PHYSICAL AND CHEMICAL CHARACTERISTICS OF WATER IN COAL-MINE PONDS, EASTERN OKLAHOMA, JUNE TO NOVEMBER 1977-81,
Geological Survey, Oklahoma City, OK. Water Resources Div.
For primary bibliographic entry see Field 5A.
W89-04647

CHEMISTRY OF A TROPICAL RAIN FOREST STREAM: CHANGES ALONG AN ALTITUDINAL GRADIENT,
Center for Energy and Environment Research, San Juan, PR.
C. G. Sanchez, C. R. Ramos Perez, W. H. McDowell, and J. Ceraso.
IN: Third Caribbean Islands Water Resources Congress. Proceedings of a Symposium held in St. Thomas, U.S. Virgin Islands, July 22-25, 1986. p 29-32, 10 ref.

Descriptors: *Water chemistry, *Geochemistry, *Weathering, *Tropical regions, *Puerto Rico, *Rain forests, *Streams, Chemical analysis, Quebrada Sonadora, Espirito Santo River, Water quality, Hydrogen ion concentration, Conductivity, Chlorine, Sodium, Calcium, Magnesium, Phosphorus, Nitrites, Nitrates.

Several factors which can affect water chemistry may vary along altitudinal gradients, including bedrock, hydrologic factors, soils, and vegetation. The bedrock in a watershed is the source of most dissolved ions in a stream. Soils could serve as a source or sink of ions through sorption-desorption reactions and removal or release of nutrients by microorganisms. Hydrologic factors such as the amount, distribution, and chemical composition of precipitation could also affect stream chemistry. One of the most obvious changes along an altitudinal gradient is the zonation of forest communities which could affect the chemical content of water because of variations in the production and decay of organic matter as well as in the chemistry of stemflow, throughfall, and overland flow. The changes in water chemistry in an undisturbed rain forest stream, Quebrada Sonador Puerto Rico, are described from its headwater to its merger with the Espirito Santo River. Within an altitudinal gradient of only 793 meters significant differences in the concentration of several dissolved ions of ecological importance could be observed. Some (like pH, conductivity, Cl, Na, and Ca) increased steadily, while others (e.g. Mg and K) first decreased then increased. Furthermore, at least NO2/NO3 showed a marked microhabitat effect. The magnitude of change of these ions was generally small, and may be caused by differences in hydrologic or soil processes. (See also W89-04665) (Lantz-PTT)
W89-04670

COMPARISON BETWEEN BULK AND WET PRECIPITATION IN THE LUQUILLO RAIN FOREST,
Center for Energy and Environment Research, San Juan, PR.
C. R. Ramos-Perez, C. Gines, and W. H. McDowell.
IN: Third Caribbean Islands Water Resources Congress. Proceedings of a Symposium held in St. Thomas, U.S. Virgin Island, July 22-25, 1986. p 35-39, 16 ref.

Descriptors: *Water chemistry, *Chemistry of precipitation, *Puerto Rico, *Water pollution sources, *Tropical regions, *Precipitation, *Rain forests, Chemical analysis, Seawater, Magnesium, Chlorine, Sulfates, Sodium, Phosphorus, Aerosols.

A preliminary analysis was conducted of data on wet and dry precipitation collected from February 1985 to January 1986 in the El Verde area of the Caribbean National Forest, Puerto Rico, as part of a nationwide monitoring program. With the exception of Ca(2+), elements common in soil such as Mg(2+), Na(+), and K(+) were not enhanced in a significant way in bulk precipitation. However, other components which are less abundant (e.g. SO4(2-) showed a significantly higher concentration in bulk samples than in wet samples. Dry deposition apparently had a small effect on the hydrogen ion concentration of rain. The precipitation in El Yunque has two major components, seawater and non-seawater. For the elements Mg(2+) and Cl(-) the mean of the ratios were 9 and 2% higher than the seawater ratio, respectively. For SO4(2+) and Ca(2+) the ratios were significantly higher than the seawater ratio. This means that while seawater is a primary source of Cl(-), Mg(2+), Na(+), and K(+) there are other sources of SO4(2+) and Ca(2+). These preliminary results also suggest that seasalt aerosols as well as other non-marine aerosols significantly impact the chemistry of the precipitation over the Caribbean region. (See also W89-04665) (Lantz-PTT)
W89-04671

INTERPRETATION OF HYDROCHEMICAL FACIES OF GROUND WATER IN GRAND CAYMAN,
Water Authority, George Town (Cayman Islands).
K. S. Ng, and R. G. B. Beswick.
IN: Third Caribbean Islands Water Resources Congress. Proceedings of a Symposium held in St. Thomas, U.S. Virgin Islands, July 22-25, 1986. p 51-55, 3 fig, 8 ref.

Descriptors: *Water chemistry, *Data interpretation, *Geochemistry, *Groundwater quality, *Grand Cayman, Aquifers, Calcium bicarbonate, Magnesium bicarbonate, Mixing, Brackish water, Chemical analysis, Groundwater recharge, Saline-freshwater interfaces, Encroachment, Saline water intrusion.

Aquifers of the major freshwater lenses of Grand Cayman are Tertiary dolostone and are predominantly unconfined. The fresh groundwater is a calcium-magnesium bicarbonate type water, which is hydraulically linked to the sea forming a thick transition zone between the fresh and salt water. Studies on the hydrochemical facies of the groundwater in Grand Cayman indicate that the dominant process controlling the water chemistry is simple mixing of the freshwater and the underlying brackish water of the transition zone. Other major chemical processes are mineral dissolution and precipitation. Chemical characters of the groundwater also provide useful information in identifying the lens boundary, area of recharge, and trend of seawater encroachment. These data are particularly valuable in the karstic coastal aquifers of Grand Cayman, where lens geometry cannot be defined by the Ghyben-Herzberg Principle. (See also W89-04665) (Author's abstract)
W89-04673

IMPACTS OF DRAINAGE FOR FORESTRY ON RUNOFF AND WATER CHEMISTRY,
Sveriges Lantbruksuniversitet, Uppsala. Dept. of Forest Soils.
For primary bibliographic entry see Field 4C.
W89-04717

STUDY OF HEAVY METAL POLLUTION IN THE TRIBUTARY RIVERS OF THE JACAREPAGUA LAGOON, RIO DE JANEIRO STATE, BRAZIL, THROUGH SEDIMENT ANALYSIS,
Comissao Nacional de Energia Nuclear de Brasil, Rio de Janeiro. Inst. de Radioproteccao e Dosimetria.
For primary bibliographic entry see Field 5A.
W89-04759

SPATIAL DISTRIBUTION OF HEAVY METALS IN SEAWATER AND SEDIMENTS FROM COASTAL AREAS OF THE SOUTHEASTERN BUENOS AIRES PROVINCE, ARGENTINA,
Instituto Argentino de Oceanografia, Buenos Aires. Lab. de Quimica Marina.
For primary bibliographic entry see Field 5A.
W89-04760

METALS CYCLES IN COASTAL ENVIRONMENTS,
Kiel Univ. (Germany, F.R.). Inst. fuer Meereskunde.
For primary bibliographic entry see Field 5B.
W89-04773

TECHNETIUM IN COASTAL ENVIRONMENTS: FIELD OBSERVATIONS AND LABORATORY EXPERIMENTS,
Centre d'Etude de l'Energie Nucleaire, Mol (Belgium). Dept. de Biologie.
For primary bibliographic entry see Field 5B.
W89-04775

GEOHYDROLOGY AND WATER QUALITY OF THE INYAN KARA, MINNELUSA, AND MADISON AQUIFERS OF THE NORTHERN BLACK HILLS, SOUTH DAKOTA AND WYOMING, AND BEAR LODGE MOUNTAINS, WYOMING,
Geological Survey, Rapid City, SD. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-04932

QUALITY OF WATER RESOURCES OF THE OUACHITA NATIONAL FOREST, ARKANSAS,
Geological Survey, Little Rock, AR. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-04938

WATER QUALITY OF THE MALHEUR LAKE SYSTEM AND MALHEUR RIVER, AND SIMULATED WATER-QUALITY EFFECTS OF ROUTING MALHEUR LAKE WATER INTO MALHEUR RIVER, OREGON, 1984-85,
Geological Survey, Portland, OR. Water Resources Div.
For primary bibliographic entry see Field 5B.
W89-04963

TRACE ELEMENT STUDIES IN A REMOTE SCOTTISH UPLAND CATCHMENT: I. CHEMICAL COMPOSITION OF SNOW AND MELTWATERS,
University of East Anglia, Norwich (England). School of Environmental Sciences.
For primary bibliographic entry see Field 5B.
W89-04971

IMPACT OF AFFORESTATION ON THE SOIL SOLUTION CHEMISTRY OF STAGNOPODZOLS IN MID-WALES,
Institute of Terrestrial Ecology, Bangor (Wales). Bangor Research Station.
For primary bibliographic entry see Field 2G.
W89-04985

USE OF A CHEMICAL EQUILIBRIUM MODEL TO UNDERSTAND SOIL CHEMICAL PROCESSES THAT INFLUENCE SOIL SOLUTION AND SURFACE WATER ALKALINITY,
Illinois Univ., Urbana. Dept. of Forestry.
For primary bibliographic entry see Field 2G.
W89-04986

ACID SULFATE SOILS OF THE MANGROVE SWAMPS OF RIVERS STATE, NIGERIA,
Rivers State Univ. of Science and Technology, Port Harcourt (Nigeria). Faculty of Agriculture.
For primary bibliographic entry see Field 3F.
W89-05007

TOTAL SELENIUM CONCENTRATION IN TAP AND BOTTLED DRINKING WATER AND COASTAL WATERS OF GREECE,
Patras Univ. (Greece). Dept. of Chemistry.
For primary bibliographic entry see Field 5B.
W89-05010

PARTICLE SIZE AND CHEMICAL CONTROL OF AS, CD, CU, FE, MN, NI, PB, AND ZN IN BED SEDIMENT FROM THE CLARK FORK RIVER, MONTANA (U.S.A.),
Montana Univ., Missoula. Dept. of Geology.
For primary bibliographic entry see Field 5B.
W89-05019

DEPTH VARIATIONS IN THE CHEMISTRY OF OGUTA LAKE IN SOUTHEASTERN NIGERIA,
Port Harcourt Univ. (Nigeria). Dept. of Zoology.
For primary bibliographic entry see Field 2H.
W89-05038

ENVIRONMENTAL AQUATIC PHOTOCHEMISTRY OF CHLORINATED AROMATIC POLLUTANTS (CAPS),
Manitoba Univ., Winnipeg. Pesticide Research Lab.
For primary bibliographic entry see Field 5B.
W89-05047

DETAILED ANALYSIS OF SULPHATE AND NITRATE ATMOSPHERIC DEPOSITION ESTIMATES AT THE TURKEY LAKES WATERSHED,
Atmospheric Environment Service, Downsview (Ontario).
For primary bibliographic entry see Field 5B.
W89-05083

ACID PRECIPITATION AND GROUNDWATER CHEMISTRY AT THE TURKEY LAKES WATERSHED,
National Hydrology Research Inst., Saskatoon (Saskatchewan).
For primary bibliographic entry see Field 5B.
W89-05087

ALKALINITY DYNAMICS IN A HARD-WATER PRAIRIE-MARGIN STREAM,
Oak Ridge National Lab., TN.
For primary bibliographic entry see Field 2E.
W89-05281

WATER ACIDIFICATION BY ADDITION OF AMMONIUM SULFATE IN SEDIMENT-WATER COLUMNS AND IN NATURAL WATERS,
Katholieke Univ. Nijmegen (Netherlands). Lab. of Aquatic Ecology.
For primary bibliographic entry see Field 5B.
W89-05290

EMISSION OF HYDROGEN FROM DEEP AND SHALLOW FRESHWATER ENVIRONMENTS,
Fraunhofer-Gesellschaft zur Foerderung der Angewandten Forschung e.V., Garmisch-Partenkirchen (Germany, F.R.). Inst. fuer Atmosphaerische Umweltforschung.
For primary bibliographic entry see Field 2H.
W89-05323

MINERALIZATION OF N AND P ALONG A TROPHIC GRADIENT IN A FRESHWATER MIRE,
Utrecht Rijksuniversiteit (Netherlands). Dept. of Plant Ecology.
For primary bibliographic entry see Field 2H.
W89-05325

COLLOIDS IN THE AQUATIC ENVIRONMENT,
Freshwater Biological Association, Ambleside (England).
E. Tipping.
Chemistry and Industry CHINAG, Vol. 15, p 485-490, August 1988. 4 fig, 1 tab, 27 ref.

Descriptors: *Water chemistry, *Reviews, *Colloids, *Aquatic environment, *Natural waters, *Particulate matter, *Trace elements, Water analysis, Chemical properties, Chemical analysis, Biochemistry, Cations, Anions, Organic compounds, Dissolved organic matter, Bank erosion, Detritus.

The biological and chemical natures of the more abundant, macromolecular suspended colloidal matter found in natural waters is reviewed. Among the colloidal aquatic particles discussed are viruses, iron and aluminum oxides, sewerage particulates, biologically precipitated MnO2, living and dead bacteria, soil aggregates, living or dead algae, and biologically or chemically precipitated SiO2 and CaCO3. The origins of the colloids vary with water type. In river, the great majority of the material is terrestrial in origin, coming largely from bank erosion; estuaries and coastal waters are usually influenced by riverine input, while lakes tend to be influenced by algae, riverine and/or from sediment resuspension. Surface chemistry and aggregation of such aquatic colloids as major cations with charge > or = 2, trace metals, inorganic anions, organic micropollutants, and natural organic matter are discussed; chemical description of colloidal surfaces allows the quantitative prediction of adsorption/desorption. The quantitative prediction of colloid stability on the basis of surface chemistry is possible in principle, but is a difficult, formidable task, requiring a more empirical approach for further progress. (Friedmann-PTT)
W89-05328

FORMATION OF WATER-IN-OIL EMULSIONS,
Nagasaki Univ. (Japan). Faculty of Fisheries.
For primary bibliographic entry see Field 5B.
W89-05437

BASIN-SCALE TRANSPORT OF DISSOLVED SPECIES IN GROUNDWATER,
Trento Univ. (Italy). Dept. of Engineering.
For primary bibliographic entry see Field 2F.
W89-05469

STATIONARY PRINCIPLES FOR FLOW AND TRANSPORT IN AQUIFERS,
Technion - Israel Inst. of Tech., Haifa.
For primary bibliographic entry see Field 2F.
W89-05471

METALS IN AQUATIC AND TERRESTRIAL SYSTEMS: SORPTION, SPECIATION, AND MOBILIZATION,
Bureau de Recherches Geologiques et Minieres, Orleans (France). Water Resources Dept.
For primary bibliographic entry see Field 5B.
W89-05556

ASSESSMENT OF METAL MOBILITY IN DREDGED MATERIAL AND MINE WASTE BY PORE WATER CHEMISTRY AND SOLID SPECIATION,
Technische Univ. Hamburg-Harburg (Germany, F.R.). Arbeitsbereich Umweltschutztechnik.
For primary bibliographic entry see Field 5B.
W89-05564

DIAGENETIC PROCESSES IN AQUATIC MINE TAILINGS DEPOSITS IN BRITISH COLUMBIA,
British Columbia Univ., Vancouver. Dept. of Oceanography.
For primary bibliographic entry see Field 5B.
W89-05565

HEAVY METAL TRANSPORT IN STREAMS--FIELD RELEASE EXPERIMENTS,
Commonwealth Scientific and Industrial Research Organization, Ryde (Australia). Div. of Fossil Fuels.
For primary bibliographic entry see Field 5B.
W89-05567

AQUEOUS GEOCHEMISTRY OF THE BRADYS HOT SPRINGS GEOTHERMAL AREA, CHURCHILL COUNTY, NEVADA,
A. H. Welch, and A. M. Preissler.
IN: Selected Papers in the Hydrologic Sciences 1986. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Supply Paper 2290. 1986. p 17-36, 10 fig, 4 tab, 35 ref.

Descriptors: *Hot springs, *Nevada, *Geochemistry, *Dissolved solids, *Water temperature, *Solubility, Sodium, Chlorides, Bromides, Sulfates, Meteoric water, Barium, Fluoride, Lead, Manganese, Boron, Strontium, Lithium.

The aqueous geochemistry of the Bradys Hot Springs geothermal system was examined to evaluate the source of recharge to the system, the thermal aquifer temperature, and the geochemical controls on the major and selected minor constituents in the thermal water. The hottest water sampled at Bradys Hot Springs contains about 2600 mg/l of dissolved solids dominated by sodium, chloride, and sulfate. Chemical geothermometer data indicate thermal aquifer temperatures ranging from 137-184 C, although a measured down-hole temperatures of 212 C has been reported. Local meteoric water that has been concentrated by evaporation is the likely source of recharge to the thermal system. The primary controls on the dissolved-solids content of the thermal water (heated, deeply circulating groundwater) apparently are evaporative concentration before recharge to the thermal aquifer and an increase in silica during passage through the thermal aquifer. Evaporative concentration and mineral solubility appear to be the primary controls on the minor constituents. Bromide is controlled primarily by evaporative concentration. Barium, fluoride, lead, and manganese concentrations may be controlled by mineral solu-

bility. Lithium and, to a lesser extent, boron and strontium, are more concentrated in the thermal water than in the local nonthermal water with the same chloride concentrations; these elements thus may be useful indicators of thermal water in the vicinity of Bradys Hot Springs when used in conjunction with chloride data. (See also W89-05586) (Author's abstract)
W89-05588

INVESTIGATION OF THE POSSIBLE FORMATION OF DIETHYLNITROSAMINE RESULTING FROM THE USE OF RHODAMINE WT DYE AS A TRACER IN RIVER WATERS,
For primary bibliographic entry see Field 5B.
W89-05589

EVALUATION OF A SUGGESTED SEQUENCE FOR THE CHEMICAL EXTRACTION OF SOLUBLE AMORPHOUS PHASES FROM CLAYS,
For primary bibliographic entry see Field 7B.
W89-05597

ASSESSMENT OF VARIABILITY IN PERFOMANCE OF WET ATMOSPHERIC DEPOSITION SAMPLERS,
Geological Survey, West Point, NY. Water Resources Div.
For primary bibliographic entry see Field 7B.
W89-05778

PHYSICAL AND CHEMICAL CHARACTERISTICS OF WATER IN COAL-MINE PONDS, EASTERN OKLAHOMA, JUNE TO NOVEMBER 1977-81,
Geological Survey, Norman, OK. Water Resources Div.
For primary bibliographic entry see Field 5B.
W89-05780

2L. Estuaries

INFLUENCE OF EVAPOTRANSPIRATION ON THE GROUNDWATER TABLE IN PEATLAND,
Hokkaido Univ., Sapporo (Japan). Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 2F.
W89-04712

METALS IN COASTAL ENVIRONMENTS OF LATIN AMERICA.
For primary bibliographic entry see Field 5A.
W89-04755

TRACE METAL DISTRIBUTION IN SEDIMENTS OF THE PATOS LAGOON ESTUARY, BRAZIL,
Fundacao Univ., Rio Grande (Brazil).
For primary bibliographic entry see Field 5A.
W89-04762

ATMOSPHERIC LEAD DEPOSITION INTO GUARAPINA LAGOON, RIO DE JANEIRO STATE, BRAZIL,
Universidade Federal Fluminense, Niteroi (Brazil). Dept. de Geoquimica.
For primary bibliographic entry see Field 5A.
W89-04763

METAL ION CONCENTRATION IN SEDIMENTS FROM HELLSHIRE, A JAMAICAN COASTAL ENVIRONMENT,
University of the West Indies, Kingston (Jamaica). Dept. of Chemistry.
For primary bibliographic entry see Field 5B.
W89-04764

GEOCHEMICAL DISTRIBUTION OF CD, CU, CR AND PB IN SEDIMENTS OF ESTUARINE AREAS ALONG THE SOUTHEASTERN BRAZILIAN COAST,
Universidade Federal Fluminense, Niteroi (Brazil). Dept. de Geoquimica.
For primary bibliographic entry see Field 5B.
W89-04765

BEHAVIOUR OF POLLUTANT METALS IN AQUATIC SEDIMENTS,
Universidade Federal Fluminense, Niteroi (Brazil). Dept. de Geoquimica.
For primary bibliographic entry see Field 5A.
W89-04766

FATE OF METALS IN BIOTA AND BIOLOGICAL INTERACTIONS IN THE TROPICAL COASTAL ZONE,
Newcastle upon Tyne Univ. (England). Dept. of Zoology.
For primary bibliographic entry see Field 5B.
W89-04767

TOTAL MERCURY LEVELS IN MARINE ORGANISMS OF THE BAHIA BLANCA ESTUARINE TROPHIC WEB,
Instituto Nacional de Investigacion y Desarrollo Pesquero, Mar del Plata (Argentina).
For primary bibliographic entry see Field 5A.
W89-04768

UPTAKE OF ZN AND CD BY COASTAL PHYTOPLANKTON SPECIES IN CULTURE,
Institut National de la Sante et de la Recherche Medicale, Paris (France).
For primary bibliographic entry see Field 5B.
W89-04769

TOTAL MERCURY, CADMIUM AND LEAD DISTRIBUTION IN TISSUES OF THE SOUTHERN SEA LION (OTARIA FLAVESCENS) IN THE ECOSYSTEM OF MAR DEL PLATA, ARGENTINA,
Instituto Nacional de Investigacion y Desarrollo Pesquero, Mar del Plata (Argentina).
For primary bibliographic entry see Field 5A.
W89-04770

LABORATORY EXPERIMENTS ON CO60 BIOACCUMULATION BY TROPICAL SEAWEEDS,
Universidade Federal do Rio de Janeiro (Brazil). Inst. de Biofisica.
For primary bibliographic entry see Field 5A.
W89-04771

BEHAVIOUR AND IMPACT ASSESSMENT OF HEAVY METALS IN ESTUARINE AND COASTAL ZONES,
Institute for Soil Fertility, Haren (Netherlands).
For primary bibliographic entry see Field 5B.
W89-04772

METALS CYCLES IN COASTAL ENVIRONMENTS,
Kiel Univ. (Germany, F.R.). Inst. fuer Meereskunde.
For primary bibliographic entry see Field 5B.
W89-04773

MINERALOGICAL CONTROL OF HEAVY METAL BEHAVIOUR IN COASTAL ENVIRONMENTS: COPPER IN RIBEIRA BAY, RIO DE JANEIRO, BRAZIL,
Universidade Federal Fluminense, Niteroi (Brazil). Dept. de Geoquimica.
For primary bibliographic entry see Field 5B.
W89-04774

METAL MONITORING IN COASTAL ENVIRONMENTS,
Uppsala Univ. (Sweden). Dept. of Hydrology.
For primary bibliographic entry see Field 5A.
W89-04776

MULTISPECIES METAL MONITORING IN TROPICAL BRAZILIAN ESTUARIES,
Fundacao Univ., Rio Grande (Brazil). Dept. of Oceanography.
For primary bibliographic entry see Field 5A.
W89-04777

SELECTED BIVALVES FOR MONITORING OF HEAVY METAL CONTAMINATION IN THE COLOMBIAN CARIBBEAN,
Universidad Nacional de Colombia, Bogota.
For primary bibliographic entry see Field 5A.
W89-04778

EICHHORNIA CRASSIPES AS A BIOLOGICAL MONITOR OF HEAVY METALS IN SURFACE WATERS,
Universidade Federal Fluminense, Niteroi (Brazil). Dept. de Geoquimica.
For primary bibliographic entry see Field 5A.
W89-04779

STRATEGIES FOR BIOLOGICAL MONITORING: THE EUROPEAN EXPERIENCE,
King's Coll., London (England). Monitoring and Assessment Research Centre.
For primary bibliographic entry see Field 5A.
W89-04780

METALS IN COASTAL ENVIRONMENTS OF LATIN AMERICA: RECOMMENDATIONS FOR A CRITICAL SITUATION,
Fundacao Univ., Rio Grande (Brazil). Dept. of Oceanography.
For primary bibliographic entry see Field 5A.
W89-04781

NATIONAL STATUS AND TRENDS PROGRAM FOR MARINE ENVIRONMENTAL QUALITY SPECIMEN BANK PROJECT: FIELD MANUAL,
National Oceanic and Atmospheric Administration, Rockville, MD. Ocean Assessments Div.
For primary bibliographic entry see Field 7B.
W89-04891

SEASONAL COMPARISON OF THE DISSOLVED FREE AMINO ACID LEVELS IN ESTUARINE AND ENGLISH CHANNEL WATERS,
Plymouth Polytechnic (England). Dept. of Environmental Sciences.
R. Evens, J. Braven, and E. I. Butler.
Science of the Total Environment STENDL, Vol. 76, No. 1, p 69-78, September 15 1988. 5 fig, 3 tab, 11 ref.

Descriptors: *Seasonal variation, *Amino acids, *Estuaries, Biota, England, English Channel, Tamar River.

Dissolved free amino acid levels and composition were measured over a 12-month period in the waters of the estuary of the River Tamar in southwest England. Both the levels and composition were similar for most of the year to those reported for the western English Channel, despite the considerable differences in chemical, physical and biological properties of the two water bodies. The levels appear to be controlled by the biota. (Author's abstract)
W89-05012

SHORT-TERM ENVIRONMENTAL VARIABILITY AND PHYTOPLANKTON ABUNDANCE IN A SHALLOW TIDAL ESTUARY: I. WINTER AND SUMMER,
Duke Univ., Beaufort, NC. Marine Lab.
W. Litaker, C. S. Duke, B. E. Kenney, and J. Ramus.
Marine Biology MBIOAJ, Vol. 96, No. 1, p 115-121, October 1987. 3 fig, 1 tab, 26 ref. NSF Grant OCE-81-13328.

Descriptors: *Estuaries, *Phytoplankton, *Estuarine environment, Seasonal variation, Nitrogen, Nitrates, Ammonium, Chlorophyll a, Water temperature, Newport River, North Carolina.

Fixed-point sampling of a shallow tidal estuary was performed hourly for 14 days in the summer of 1982 and again in the winter of 1983. This sampling regime was of statistically appropriate duration to allow characterization of the variability between periods of 2 to 96 h by spectral analysis of the time-series. The project (PULSE) took place in the Newport River Estuary, located behind the Outer Banks of North Carolina. Twenty-eight parameters were monitored, encompassing the meteorology, hydrology, water chemistry and phytoplankton-production physiology. Although the annual cycle was monitored, only the winter and summer seasons are compared here, i.e., the lowest water temperatures with the highest water temperatures. The physics, chemistry, and biology of the estuary at the hourly scale were highly variable and non-random. The estuary is riverine in winter; growth-limiting N is supplied as nitrate and ammonium by runoff from the drainage basin. In summer, the estuary is lagoonal; N is supplied as ammonium by biological regeneration. Chlorophyll a biomass varies primarily at the 4 day period in winter and at the diel period in summer. Although finely tuned to environmental variability, phytoplankton abundances were at equilibrium insofar as daily chlorophyll production was balanced by losses, i.e., grazing, export and deposition. Most important, high-frequency processes, here periods at the scale of cell division times, can be very important in phytoplankton ecology. (Author's abstract)
W89-05033

SKETCHY OUTLINE OF THE FATE OF ORGANIC MATTER IN THE DUTCH WADDEN SEA (WITH SPECIAL EMPHASIS TO SULFATE IN THE SEDIMENT-WATER INTERFACE),
Nederlands Inst. voor Onderzoek der Zee, Texel.
J. H. Vosjan.
Hydrobiological Bulletin HYBUD9, Vol. 21, No. 2, p 127-132, December 1987. 1 tab, 22 ref.

Descriptors: *Coastal waters, *Organic matter, *Marine sediments, *Sediment-water interfaces, *Wadden Sea, *Sulfates, *Microorganisms, *Respiration, Carbon cycle.

In ecosystems like the Dutch Wadden Sea only a crude carbon budget can be calculated. There are data gaps in space as well as in time, especially for subtidal sediments of inlets and gullies. Quantification of functional groups of anaerobic organisms (manganese reducers, denitrifiers, iron reducers, methane formers) is also difficult. The role and quantitative importance of fermenting organisms and the quantification of the use of the reduced end products of anaerobic respiring organisms need to be studied in more detail. (Author's abstract)
W89-05037

CONTRIBUTION OF THE BACTERIAL AND MICROPHYTOBENTHIC MICROFLORA IN THE ENERGETIC DEMAND OF THE MEIOBENTHOS IN AN INTERTIDAL MUDDY SEDIMENT (KERGUELEN ARCHIPELAGO),
Laboratoire Arago, Banyuls-sur-Mer (France).
M. Bouvy.
Marine Ecology MAECDR, Vol. 9, No. 2, p 109-122, 1988. 7 fig, 3 tab, 62 ref.

Descriptors: *Aquatic bacteria, *Benthic flora, *Marine sediments, *Intertidal areas, *Organic matter, *Carbon, *Nitrogen, *Food chains, *Primary productivity, Seasonal variation, Photosynthesis, Kerguelen Archipelago.

An intertidal mud sediment in the Kerguelen Archipelago, in the Indian Ocean, was sampled weekly from January 1982 to March 1983. Measurements were taken for organic matter (C and N) and biological (bacteria, microphytobenthos, and meiofauna) parameters. The sediment is rich in organic matter, with a mean organic C content of 130 g C/sq m. Benthic living components yield low mean biomasses in relation to the total organic pool. Besides some marine inputs, the main allochthonous source was identified as terrestrial inputs. Benthic activities seemed strongly governed by food availability and not by temperature. Obvious seasonal changes in bacterial abundances (direct counts), primary production, and meiofauna distributions were observed. Photosynthetic production reached high values (up to 2275 mg C/sq m/d), reflecting the presence of a dense microphytobenthos. Preliminary energy budgets for two seasons (spring and winter) were constructed. In both periods, the measured primary production can support the high meiofauna production. (Author's abstract)
W89-05046

HYDROLOGY OF NATURAL WETLANDS AND WET NATURE RESERVES,
Agricultural Univ., Wageningen (Netherlands). Dept. of Land and Water Use.
For primary bibliographic entry see Field 2H.
W89-05141

ACCUMULATION AND EXCRETION OF FIVE HEAVY METALS BY THE SALTMARSH CORDGRASS SPARTINA ALTERNIFLORA,
Hackensack Meadowlands Development Commission, Lyndhurst, NJ.
For primary bibliographic entry see Field 5B.
W89-05236

OCCURRENCE OF THE DINOFLAGELLATE, GONYAULAX TAMARENSIS, IN NEW JERSEY,
National Marine Fisheries Service, Highlands, NJ. Sandy Hook Lab.
M. S. Cohn, P. Olsen, J. B. Mahoney, and E. Feerst.
Bulletin of the New Jersey Academy of Sciences, Vol. 33, No. 2, p 45-49, Fall 1988. 24 ref, 1 fig.

Descriptors: *Dinoflagellates, *Gonyaulax, *New Jersey, *Coastal waters, *Red tide, Biological samples, Surveys, Aquatic populations.

Occurrence of paralytic shellfish poisoning and red tide, associated with the major toxic dinoflagellate in the northeast region of the United States, Gonyaulax tamarensis (Protogonyaulax tamarensis), has not been reported in New Jersey. In recent years, however, several investigators have found the species to be widely distributed and occasionally in high numbers in nearby Long Island, New York, waters. This prompted a survey, which encompassed 102 sampling sites along most of the New Jersey coastline. G. tamarensis planktonic cells and benthic cysts were detected, although not consistently, at only two locales in the Atlantic City area. (Author's abstract)
W89-05237

SHELLFISH CULTIVATION AND FISHERY BEFORE AND AFTER A MAJOR FLOOD BARRIER CONSTRUCTION PROJECT IN THE SOUTHWESTERN NETHERLANDS,
Rijksinstituut voor Visserijonderzoek, Yerseke (Netherlands). Molluscan Shellfish Research Dept.
For primary bibliographic entry see Field 8I.
W89-05239

NEW JERSEY'S COASTAL WATER QUALITY MANAGEMENT PROJECT - METHODOLOGIES FOR THE PROTECTION OF ESTUARINE WATER QUALITY AND SHELLFISH RESOURCES,
New Jersey Dept. of Environmental Protection, Trenton. Div. of Water Resources.
For primary bibliographic entry see Field 5G.
W89-05240

OYSTER AND SHRIMP PRODUCERS IN ESTUARINE AREAS OF THE GULF OF MEXICO: ECOLOGICAL CONSTRAINTS, ECONOMIC INCENTIVES AND CONFLICTUAL MANAGEMENT,
Laval Univ., Quebec. Dept. de Anthropologie.
For primary bibliographic entry see Field 6B.
W89-05241

RAPID RESPONSES TO STRESS IN EURYTEMORA AFFINIS,
Maryland Univ. Baltimore County, Catonsville. Dept. of Biological Sciences.
B. P. Bradley, R. Hakimzadeh, and J. S. Vincent.
Hydrobiologia HYDRB8, Vol. 167/168, p 197-200, October 15, 1988. 2 fig, 23 ref.

Descriptors: *Copepods, *Thermal stress, *Temperature effects, *Sublethal effects, *Estuarine environment, Eurytemora affinis, Biochemistry, Proteins, Biological membranes.

E. affinis can adjust to temperature stress in a matter of hours. Adaptation is greater in a varying temperature than in a constant temperature, consistent with the estuarine habitat of this calanoid. The species has the capacity to adjust both in the short-term as individuals and also genetically over a number of generations. The adjustments have been examined at several levels of organization. In whole copepods the time an individual becomes comatose when exposed to a 32 C temperature and increasing by 1/2 C at 5 min. intervals, has been used as a repeatable assay and gives a good prediction of survival at 30 C, the ecological limit of the species in Chesapeake Bay, USA. At the molecular and cellular levels, two adaptive mechanisms which have been observed in temperature stressed copepods are the synthesis of novel proteins and phase changes in plasma membrane lipids. Both of these mechanisms have potential for further understanding the adaptation of Eurytemora to variable temperatures. They may also have application as indicators of sublethal stress. (Author's abstract)
W89-05251

DYNAMICS OF THE FORESTED SHORELINE AND RECENT VARIATIONS IN THE LEVEL OF THE SAINT LAWRENCE RIVER (DYNAMIQUE D'UNE BORDURE FORESTIERE ET VARIATIONS RECENTES DU NIVEAU DU FLEUVE SAINT-LAURENT),
Laval Univ., Quebec. Centre d'Etudes Nordiques.
For primary bibliographic entry see Field 2E.
W89-05254

TIDAL SALT MARSH RESTORATION,
North Carolina State Univ. at Raleigh. Dept. of Soil Science.
For primary bibliographic entry see Field 5G.
W89-05255

LOUISIANA WETLAND LOSS: A REGIONAL WATER MANAGEMENT APPROACH TO THE PROBLEM,
Louisiana State Univ., Baton Rouge. Inst. for Environmental Studies.
P. H. Templet, and K. J. Meyer-Arendt.
Environmental Management EMNGDC, Vol. 12, No. 2, p 181-192, March 1988. 8 fig, 3 tab, 53 ref.

Descriptors: *Louisiana, *Environmental effects, *Coastal marshes, *Wetlands, *Watershed management, *Water shortage, *Hydraulic structures, Coastal waters, Estuaries, Water distribution, Water conveyance, Sediment transport, Sediment distribution, Flood plains, Marshes, Channel accretion, Seasonal variation.

Loss of Louisiana's coastal wetlands has reached catastrophic proportions. The loss rate is approximately 150 sq km/yr (100 acres/day) and is increasing exponentially. Total wetland loss since the turn of the century has been almost 0.5 million ha (1.1 million acres) and represents an area larger than Rhode Island. The physical cause of the problem lies in man's attempts to control the Mississippi River's flooding, while enhancing navigation and extracting minerals. Levee systems and control structures confine sediments that once nourished the wetlands to the river channel. As a consequence, the ultimate sediment deposition is in deep Gulf waters off the Louisiana coast. The lack of sediment input to the interdistributary wetlands

results in an accretion deficit. Natural and human-induced subsidence exceeds accretion so that the wetlands sink below sea level and convert to water. The solution is to provide a thin veneer of sediment (approximately 0.6 cm/yr; an average of 1450 g/sq m/yr) over the coastal marshes and swamps and thus prevent the submergence of vegetation. The sediment source is the Mississippi River system. Calculations show that 9.2% of the river's annual suspended sediment load would be required to sustain the deltaic plain wetlands. It should be distributed during the six high-water months (December-June) through as disaggregated a network as possible. The problem is one of distribution; how can the maximum acres of marsh be nourished with the least cost. At present, the river is managed through federal policy for the benefit of navigation and flood control. A new policy structure, recognizing the new role for the river-sediment distribution, is recommended; this policy uses the water, sediment, and nutrients of the Mississippi River constructively to replenish and nourish the wetland of south Louisiana. (Author's abstract)
W89-05338

MANAGEMENT AND VALUATION OF AN ENVIRONMENTALLY SENSITIVE AREA: NORFOLK BROADLAND, ENGLAND, CASE STUDY,
University of East Anglia, Norwich (England). School of Environmental Sciences.
For primary bibliographic entry see Field 7A.
W89-05339

EUTROPHICATION OF BUTTERMILK BAY, A CAPE COD COASTAL EMBAYMENT: CONCENTRATIONS OF NUTRIENTS AND WATERSHED NUTRIENT BUDGETS,
Marine Biological Lab., Woods Hole, MA.
For primary bibliographic entry see Field 5B.
W89-05343

NEW METHOD OF DESCRIBING BOTTOM STRESS IN TWO-DIMENSIONAL HYDRODYNAMICAL MODELS OF SHALLOW HOMOGENEOUS SEAS, ESTUARIES, AND LAKES,
Western Australia Univ., Nedlands. Centre for Water Research.
For primary bibliographic entry see Field 2H.
W89-05347

BIOACCUMULATION OF POLYNUCLEAR AROMATIC HYDROCARBONS BY THE CLAM, RANGIA CUNEATA, IN THE VICINITY OF A CREOSOTE SPILL,
New Orleans Univ., LA. Center for Bio-Organic Studies.
For primary bibliographic entry see Field 5B.
W89-05360

CHEMICAL AND PHYSICAL CHARACTERISTICS OF WATER IN ESTUARIES OF TEXAS, OCTOBER 1976-SEPTEMBER 1978,
Geological Survey, Austin, TX. Water Resources Div.
J. C. Fisher.
Texas Department of Water Resources Report 282, October 1983. 215p, 10 tab, 14 maps, 15 ref.

Descriptors: *Texas, *Water chemistry, *Water quality, *Estuaries, *Data collections, *Physical properties, Chemical properties, Seasonal variation, Coastal waters, Dissolved oxygen, Specific conductivity, Temperature, Hydrogen ion concentration, Turbidity, Inorganic compounds, Biochemical oxygen demand, Organic carbon, Ammonium, Nitrates, Nitrites, Phosphates.

Basic data is presented on the chemical and physical characteristics of water in the estuaries of Texas for October 1976-September 1978. The properties or constituents that were measured in the field are dissolved oxygen (DO), specific conductance, temperature, pH, and transparency by Secchi disk. Analyses conducted in the laboratory include the principal inorganic ions, biochemical oxygen demand, total organic carbon, ammonium, nitrite, nitrate, and total phosphate. (Author's abstract)
W89-05419

PRELIMINARY ANALYSIS OF NUTRIENT MONITORING DATA FOR THE SUSQUEHANNA RIVER AND SELECTED TRIBUTARIES: JANUARY 1, 1985 - DECEMBER 31, 1987,
Susquehanna River Basin Commission, Harrisburg, PA.
For primary bibliographic entry see Field 5G.
W89-05511

ECOSYSTEM ANALYSIS OF THE CALCASIEU RIVER/LAKE COMPLEX (CALECO).
McNeese State Univ., Lake Charles, LA.
For primary bibliographic entry see Field 4C.
W89-05529

BENTHIC FAUNAL COLONIZATION OF AN OFFSHORE BORROW PIT IN SOUTHEASTERN FLORIDA,
Florida Atlantic Univ., Boca Raton. Coll. of Science.
P. R. Bowen, and G. A. Marsh.
Available from the National Technical Information Service, Springfield, VA 22161. Miscellaneous Paper D-88-5, October 1988. Final Report. 70p, 10 fig, 6 tab, 55 ref, 4 append.

Descriptors: *Coastal waters, *Environmental effects, *Dredging, *Borrow Pits, *Benthic fauna, *Florida, Benthic environment, Ecosystems, Species diversity, Population density, Polychaetes, Crustaceans.

When sediments are dredged from offshore, either for a Corps project or a permitted activity, borrow pits are created. As part of a program to examine the environmental effects of dredging, this study addresses concerns about the changes that may occur in the benthic fauna associated with these dredged borrow sites. Benthic faunal colonization of a newly created borrow pit off Delray Beach, Florida, was monitored. For comparative purposes, a single sampling of an adjacent 5-year-old borrow pit was conducted concurrently with the final sampling of the new pit. Colonization of the new pit was rapid, with 35 species and 1,081 individuals/sq m collected at the initial sampling, 21 days postdredging. Abundance peaked at a mean density of 1,761 individuals/sq m in the third sampling period (170 days postdredging), and species richness peaked at the fifth sampling period (296 days postdredging) with 57 species. Polychaete annelids and peracarid crustaceans were numerically the most important initial colonizers of the new pit, together comprising 89.3% of the fauna. Species diversity and equitability were lowest during the first sampling period (4.21 and 0.82, respectively) and, although variable, increased toward the end of the study (5.10 and 0.92, respectively). Relative to the old pit, the disturbed area showed complete recovery based on several aspects of community structure, although differences in species composition were evident. (Author's abstract)
W89-05752

3. WATER SUPPLY AUGMENTATION AND CONSERVATION

3A. Saline Water Conversion

INTEGRATION OF RAIN WATER CISTERN SYSTEMS WITH OTHER SOURCES OF WATER IN THE CARIBBEAN,
Caribbean Research Inst., St. Thomas, VI. Water Resources Research Center.
For primary bibliographic entry see Field 3B.
W89-04669

MOBILE REVERSE OSMOSIS DEMONSTRATION PLANT,
Central Salt and Marine Chemicals Research Inst., Bhavnagar (India).
V. J. Shah, A. V. Rao, and M. M. Taqui Kahn.
Desalination DSLNAH, Vol. 69, No. 2, p 161-169, July 1988. 5 fig, 2 tab, 3 ref.

Descriptors: *Reverse osmosis, *Desalination, *Water treatment, *Desalination apparatus, *Pretreatment of water, Osmosis, Drinking water, India, Chemical reactions, Performance evaluation.

Reverse osmosis (RO) is a versatile technology for water desalination. To popularize this technology and give on-the-spot demonstrations, a 10,000 l/d capacity plant with pre- and post-treatment equipment was designed, prepared and installed in a bus. Demonstration programs were conducted in various parts of India threatened with drinking water shortages. The simple pretreatment system consists of a sand filter and two dosing pumps for dosing chemicals. The RO plant consists of a high-pressure triplex pump, RO module system including six pressure vessels 5 ft., in length, each accommodating two spiral modules, a back pressure regulating valve, and electrical control panel consisting of an ammeter, voltmeter, frequency meter, time totalizer, and various electrical starters. A flow diagram and floor layout of the plant is presented. The mobile plant is designed in such a way so as to minimize the time required to make it operational. The demonstration program was designed to encourage participation in the exhibitions. As a result of the bus exhibition, local authority and government officials were convinced of the usefulness of RO technology for providing safe drinking water, and several stationary plants have been installed for performance study purposes. (Friedmann-PTT)
W89-05334

SOLAR DESALINATION AS A MEANS TO PROVIDE INDIAN VILLAGES WITH DRINKING WATER,
Central Salt and Marine Chemicals Research Inst., Bhavnagar (India).
S. D. Gomkale.
Desalination DSLNAH, Vol. 69, No. 2, p 171-176, July 1988. 1 fig, 3 tab, 3ref.

Descriptors: *Desalination, *Water treatment, *Drinking water, *Cost analysis, *India, *Electrodialysis, *Solar desalination, Desalination apparatus, Water supply, Technology, Solar stills.

The possibilities of adopting desalination - particularly solar desalination to supply drinking water of villages in arid zones are examined. The costs of water obtained by desalination and water transported by pipelines are compared; solar-cell-operated electrodialysis seems to be more advantageous for desalting brackish water than conventional solar stills. There are many small villages in India where solar powered desalination plants will have to be used to supply drinking water. The capacity of such plants will only be a few cu m/d, enough to provide water for drinking and cooking at a rate of 10 L/d per person. Given the present state of desalination technology in India, solar stills will be used for desalting saline water with total dissolved solids (TDS) higher than 10,000 ppm. For brackish water with TDS less than 5000 ppm, photovoltaic electrodialysis (PVED) is more advantageous and work in the appropriate areas of PVED will not only bring down the cost of water, but may also lead to its use for desalting higher salinity water. (Friedmann-PTT)
W89-05335

OPERATIONAL EXPERIENCE WITH SOLAR STILLS IN AN INDIAN VILLAGE AND THEIR CONTRIBUTION TO THE DRINKING WATER SUPPLY,
Central Salt and Marine Chemicals Research Inst., Bhavnagar (India).
S. D. Gomkale.
Desalination DSLNAH, Vol. 69, No. 2, p 177-182, July 1988. 1 fig, 1 tab, 1 ref.

Descriptors: *Desalination, *Water treatment, *India, *Drinking water, *Water supply, *Solar

stills, Saline water, Community development, Performance evaluation.

The solar still is the oldest device used for desalting saline water to provide drinking water to small, isolated communities. In India, a few solar still plants have been installed to supply drinking water. The experience from operation of a plant at Awania forms the basis for an examination of the possible contribution of solar stills the drinking water supply of Indian villages. The plant in Awania has 90 solar stills with an evaporating area of 1866.6 sq m. A vertical axis Savonius rotor windmill pumps saline water from the well, which supplies water with total dissolved solids (TDS) ranging between 3000 and 5000 ppm. A 120 peak-watt photovoltaic solar cell-operated pump pumps product water from an underground collection tank to the supply tank and saline water from the well to the feed tank. Overall, the plant performed poorly because of (1) improper maintenance of the plant and (2) leakage of water vapor through joints. The chance of success of solar stills depends on greater user participation, a lowering of capital costs and the availability of a better sealant. (Friedmann-PTT)
W89-05336

GEOLOGY: SEISMOTECTONIC INVESTIGATIONS,
For primary bibliographic entry see Field 8E.
W89-05696

3B. Water Yield Improvement

WATER USE PLAN FOR AQUACULTURE IN THE VIRGIN ISLANDS,
College of the Virgin Islands, St. Croix. Agricultural Experiment Station.
J. E. Rakocy.
IN: Third Caribbean Islands Water Resources Congress. Proceedings of a Symposium held in St. Thomas, U.S. Virgin Islands, July 22-25, 1986. p 13-16, 7 ref.

Descriptors: *Water harvesting, *Water use, *Water management, *Virgin Islands, *Aquaculture, *Water resources management, Agriculture, Fish farming, Rainfall, Precipitation, Water supply, Impaired water use, Irrigation.

The Virgin Islands are semiarid and subject to frequent shortages of freshwater. There are a number of systems that could be utilized for culturing freshwater fish that would actually enhance the water supply or have little effect on water consumption. Rainwater harvesting would provide the main source of freshwater for aquaculture. To make maximum use of the limited freshwater supply, water recycling would be essential. Tilapia is a freshwater fish with good potential for culture in the Virgin Islands. Appropriate systems for tilapia culture include the following: (1) cage culture in watershed ponds; (2) pond culture in watershed ponds using predator fish to control reproduction and gill nets for harvesting; (3) pond culture in dug ponds in conjunction with a watershed pond for water supply and reuse of drainage water; (4) tank culture in a flow-through system in conjunction with a watershed pond for water supply and reuse of drainage water; (5) tank culture in a flow-through system for plant crop irrigation; (6) tank culture in a closed recirculating system integrated with vegetable hydroponics and utilizing rainwater catchments for water supply; and (7) cage, pond and tank culture utilizing agricultural wastewater. (See also W89-04665) (Author's abstract)
W89-04668

INTEGRATION OF RAIN WATER CISTERN SYSTEMS WITH OTHER SOURCES OF WATER IN THE CARIBBEAN,
Caribbean Research Inst., St. Thomas, VI. Water Resources Research Center.
H. H. Smith.
IN: Third Caribbean Islands Water Resources Congress. Proceedings of a Symposium held in St. Thomas, U.S. Virgin Islands, July 22-25, 1986. p 17-21, 1 fig, 2 tab, 7 ref.

Descriptors: *Conjunctive use, *Virgin Islands, *Water resources development, *Water management, *Model studies, *Cisterns, Water supply, Caribbean, Desalination, Simulation analysis, Groundwater management, Water harvesting.

In the Caribbean region traditional sources of water are no longer fully meeting demands. Among these water sources are ephemeral streams, groundwater and rain harvested cistern water. When capital is available, an attractive option is to invest in sophisticated technology, such as desalination, to provide water. While several factors should be considered, conjunctive use strategies should be a principal concern. Conjunctive management schemes have been developed for various combinations of water sources but none have been proposed which consider the characteristics of the water sources in the Caribbean. A conjunctive use model was developed to simulate a water supply system incorporating rain water cisterns, groundwater and desalination. Some of the pertinent data input to the model were a daily demand of 788,000 gallons, a total catchment area of 9,086,000 sq ft and a catchment efficiency of 85%. In the simulation, the model first determines based on the rainfall, the amount of water harvested and the volume of groundwater available. The harvested water is added to storage while an attempt is made to satisfy demands using groundwater. Demand not satisfied from groundwater is met with harvested water and the excess harvested water, if any, stored in cisterns. Shortages are supplied from supplemental storages if available. Based on the specified operating rule, a check is made to see if the desalination plant should be on line. The simulation is repeated for the period specified with records being kept of shortages, surpluses and plant operation for output as required. Using the output of the conjunctive use model, the actual total operation time of the plant is determined. (See also W89-04665) (Lantz-PTT)
W89-04669

WATER CONSERVATION,
Agricultural Research Service, Phoenix, AZ. Water Conservation Lab.
For primary bibliographic entry see Field 3F.
W89-05129

WATER USE BY SALTCEDAR AND BY REPLACEMENT VEGETATION IN THE PECOS RIVER FLOODPLAIN BETWEEN ACME AND ARTESIA, NEW MEXICO,
Geological Survey, Lakewood, CO. Water Resources Div.
E. P. Weeks, H. A. Weaver, G. S. Campbell, and B. D. Tanner.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Professional Paper 491-G, 1987. 33p, 12 fig, 5 tab, 41 ref.

Descriptors: *Evapotranspiration, *Phreatophytes, *Micrometeorology, *NewMexico, *Pecos River, *Saltcedar, Energy budget, Water yield improvement, Eddy correlation.

Water-use estimates for saltcedar and for replacement plant communities following root plowing in the Pecos River floodplain between Acme and Artesia, New Mexico, were made by the eddy-correlation technique and a combined eddy-correlation energy-budget technique during 1980-82. Twenty-seven measurements of daily water use were obtained for various periods during the growing season--17 measurements from four saltcedar thickets and 10 from three strands of replacement vegetation. Large uncertainties exist in these estimates because of problems in extrapolating the data seasonally and aerally, and because of discrepancies between the two methods. Nonetheless, the measurements indicate that annual water use by saltcedar probably is about 0.3 meters greater than that by the replacement vegetation. Such reductions in water use should have resulted in increased base flow of the Pecos River of 1.2-2.5x10(7) cubic meters per year (10,000 to 20,000 acre-feet per year). The fact that such gains have not been identified from stream-gage records may arise from masking of short-term gains by variations in climate and in groundwater pumpage and from a continuing decline in the groundwater contribution to base flow from the shallow aquifer. (USGS)
W89-05775

3C. Use Of Water Of Impaired Quality

READJUSTING THE WATER BALANCE TO COMBAT DRYLAND SALTING IN SOUTHERN AUSTRALIA: CHANGING THE HYDROLOGY OF A TEXTURE CONTRAST SOIL BY DEEP RIPPING,
Land Protection Service, Bendigo (Australia).
J. Brouwer, and R. H. M. van de Graaf.
Agricultural Water Management AWMADF, Vol. 14, No. 1-4, p 287-298, August 1988. 4 fig, 3 tab, 14 ref.

Descriptors: *Water budget, *Saline soils, *Australia, *Agricultural hydrology, *Deep ripping, *Rainfall infiltration, Saline water, Pastures, Soil-water-plant relationships, Crop yield, Evapotranspiration.

Dryland salting is one of the biggest problems in dryland agriculture in southern Australia. It has been caused by the replacement of the original, deep-rooted, perennial trees and shrubs with shallow-rooted, annual crops and pastures. The accompanying decrease in evapotranspiration has caused an increase in deep infiltration to the groundwater. The rising groundwater has in many areas been salinized through mobilization of salts previously stored in the regolith above the groundwater table. The effect on agriculture where such saline groundwater rises to or close to the surface is disastrous. To remedy the problem deep infiltration must be reduced again, preferably by increasing plant water use and at the same time increasing agricultural production. In this paper details are presented of a study in western Victoria of the relative effects of conventional tilling and deep ripping on water movement under, and yield of, phalaris and lucerne pastures on a texture contrast soil. Deep ripping reduced water logging and thus increased lucerne survival. Deep ripping increased penetrability to roots. It appeared to increase yield of both lucerne and phalaris significantly, and thus their water use. Deep ripping appeared, however, to decrease run-off and increase lateral flow to increase deep infiltration. In addition it was observed that on this particular texture contrast soil the first major throttle to downward flow of water is not at the top of the B horizon, but near the top of the C horizon. This would have considerable ramifications in terms of soil management. (Author's abstract)
W89-05134

REUSE AND DISPOSAL OF HIGHER SALINITY SUBSURFACE DRAINAGE WATER: A REVIEW,
California Regional Water Quality Control Board, Sacramento.
D. W. Westcot.
Agricultural Water Management AWMADF, Vol. 14, No. 1-4, p 483-511, August 1988. 6 fig, 8 tab, 81 ref.

Descriptors: *Saline water, *Subsurface drainage, *Drainage, *Water reuse, *Irrigation water, *Literature review, *Irrigation practices, Water use efficiency, Reviews, Irrigation effects.

The 'dilution by discharge' to usable water supplies is the most widely practiced 'disposal' alternative. There is little incentive for the individual farmers to change and undertake direct reuse. Continuing water supply degradation in many areas, however, is likely to force changes in this practice but direction will need to come from basinwide policy makers. Recent research shows that several options for drainage water reuse for crop production are available but that much more work is needed to make it widely applicable to commercial production practices. There is a need to increase research in the reuse of drainage water in areas underlain by shallow brackish and saline ground

water tables. Expansion of this work will greatly increase our options for reuse. Eventually use and reuse of subsurface drainage water will produce a water so brackish or saline that its further use for crop production, wetlands enhancement or agroforestry is nil. Isolating the unusable brackish or saline drainage requires a disposal point. Evaporation basins are beginning to be used but salt and trace element build-up in these disposal systems may make them only an interim or temporary solution. Eventually the salt must be transported and discharged to an acceptable disposal site. Historically, this has been the ocean. The amount of salt discharged to the ocean each year by drainage systems is not likely to exceed that which would normally be discharged by the natural river systems which are providing the irrigation supply water. (Vernoyy-PTT)
W89-05152

3F. Conservation In Agriculture

RECONNAISSANCE INVESTIGATION OF WATER QUALITY, BOTTOM SEDIMENT, AND BIOTA ASSOCIATED WITH IRRIGATION DRAINAGE IN THE KENDRICK RECLAMATION PROJECT AREA, WYOMING, 1986-87,
Geological Survey, Cheyenne, WY. Water Resources Div.
For primary bibliographic entry see Field 5C.
W89-04899

ACID SULFATE SOILS OF THE MANGROVE SWAMPS OF RIVERS STATE, NIGERIA,
Rivers State Univ. of Science and Technology, Port Harcourt (Nigeria). Faculty of Agriculture.
E. M. Ossom, N. O. Isirimah, A. G. Ojanuga, and C. L. Rhykerd.
Proceedings of the Indiana Academy of Science PIACAP, Vol. 96, p 483-487, 1986. 3 tab, 15 ref.

Descriptors: *Wetlands, *Soil analysis, *Mangrove swamps, *Nigeria, *Acidic soils, *Soil properties, *Swamps, *Land reclamation, Sulfates, Brackish water, Saline water, Water-holding capacity.

Soils of tidal brackish-water swamps and salt-water tidal mangrove swamps in Nigeria were investigated. The sites included mangrove swamps of Brass and Degema in the Niger Delta and were analyzed for soil morphology, water holding capacity, soil pH, macronutrient and other nutrient status, and agricultural implications. It was observed that in both the tidal brackish-water and tidal salt-water mangrove swamps, the soils were fibrous, spongy peats undergoing different stages of development. They were also composed of soft, mangrove fibers easily destroyed by rubbing between the thumb and forefinger. The peats were sandy clay loam in texture. The water saturation varied from 36 to 70% and was related to the total organic matter content of the soils. In the wet state, soil pH was between 4.7 and 7.0 but on drying soil pH dropped drastically to less than 4.0 in most soils. Total N was relatively higher than in the non-organic or well-drained soils of the same environment. The range of 0.06 to 0.71% indicated the high N supplying potential of the mangrove swamp soils. Available P was quite low, in the range of 1.6 to 3.4 ppm. Water soluble Mg was the highest (101 ppm) among the macronutrients while P was the lowest (9 ppm). About 19% sulfur was detected in these soils. The concentration of water-soluble and exchangeable cations was in the order of Fe > Si > Al > Mn. Despite the high levels of toxic ions and high potential acidity in the mangrove swamp soils, their high water holding capacity, nutrient levels and organic matter contents suggest that these soils can be used for agricultural, forestry and fishery purposes if increased classification and characterization work and massive investments are made for land reclamation and soil amendments, using improved planting material including adaptive species. (Miller-PTT)
W89-05007

MINERAL COMPOSITION OF AZOLLA PINNATA IN RELATION TO COMPOSITION OF FLOODWATERS IN BANGLADESH,
Durham Univ. (England). Dept. of Botany.
J. A. Rother, and B. A. Whitton.
Archiv fuer Hydrobiologie AHYBA4, Vol. 113, No. 3, p 371-380, September 1988. 1 fig, 5 tab, 22 ref. Overseas Development Administration Contracts R3630 and R3983, Commission of the European Communities Contract TSD-A.207.

Descriptors: *Rice, *Azolla, *Minerals, *Floodwater, *Bangladesh, Sodium, Potassium, Magnesium, Calcium, Manganese, Iron, Zinc, Nitrogen, Phosphorus.

The mineral composition of Azolla pinnata was measured for populations from 7 different deepwater rice locations, including repeat samples from two of them. The mean composition (microg/g) for populations near the time of the flood peak was: Na, 4292; K, 30,120; Mg, 4042; Ca, 5978; Mn, 490; Fe, 1088; Zn, 78.8; N, 42,290; P, 2383; the range of values for N, expressed as a percentage of the mean, was much less (91-108%) than for any other element. No significant relationship was found between the concentration of the element in the plant and that in the ambient water on any particular sampling occasion. Although these deepwater rice fields have lower concentrations of most ions than the environmental concentrations reported in most other studies of Azolla, the composition of the plants appears quite similar; possible differences are higher K and lower Fe and Zn contents. The field populations with the lowest P content had red leaves (due to anthocyanin), but laboratory populations with much lower P contents had only very slight red pigmentation. The low population densities in the deepwater rice fields probably result from a combination of low ambient P, relatively high temperatures and wind action leading to plants being trapped in the more shaded parts of the fields. It is suggested that deliberate enhancement of populations towards the end of the flood season should be tested as a means of increasing the N content of soils after the water has gone. (Author's abstract)
W89-05025

EFFECTS OF DRAINAGE ON CROPS AND FARM MANAGEMENT,
Institute for Land and Water Management Research, Wageningen (Netherlands).
For primary bibliographic entry see Field 4C.
W89-05107

EFFECT OF WATERTABLE DEPTH AND WATERLOGGING ON CROP YIELD,
Bologna Univ. (Italy). Inst. of Agronomy and Field Crops.
L. Cavazza, and P. Rossi Pisa.
Agricultural Water Management AWMADF, Vol. 14, No. 1-4, p 29-34, August 1988. 5 fig, 1 tab, 5 ref.

Descriptors: *Groundwater level, *Water table, *Waterlogging, *Crop yield, *Agricultural hydrology, *Soil-water-plant relationships, Soil water table, Wheat, Water table fluctuations, Drainage ditches.

Wheat was grown on a plot with an artificial slope of 10%, the difference between top and bottom being 2.5 m. The lowest part corresponded with the bottom of a drainage ditch. The watertable depth varied along the slope; it was always near zero at the bottom. Near the top, groundwater depth, although variable in summer, ranged around 1.5 m. Grain yield was affected by watertable depth and waterlogging duration. The maximum was reached at an average depth 125 cm, and at deeper water levels it declined slightly due to shortage of water. When the average watertable depth throughout the season was 12 cm, the yield was only 25% of this maximum and it reached 82% at an average depth of 25 cm. The sum of exceedances in winter (SEW) is the number of days that the target level is exceeded, multiplied by the magnitude of exceedance in cm. When the SEW index was calculated with threshold values ranging from 0 to 80 cm, the yield response curves fell sharply above a critical value for SEW that depends on the threshold chosen. At slightly higher values total yield loss occurred. With low threshold values the response curves drop rapidly at first, and then flex; with high thresholds these curves initially remain horizontal and then bend gradually downward. The 40-cm threshold gives a practically linear response, from 100% to 66% of yield; thereafter yield collapses. (Author's abstract)
W89-05109

EFFECT OF WATERTABLE ON YIELD AND ROOT DEPTH OF WINTER WHEAT IN THE FRENCH WEST CENTRAL ATLANTIC MARSHLANDS,
Institut National de la Recherche Agronomique, Paris (France).
Y. Pons.
Agricultural Water Management AWMADF, Vol. 14, No. 1-4, p 35-42, August 1988. 4 tab, 4 fig, 16 ref.

Descriptors: *Water table, *Crop yield, *Root development, *Wheat, *Agricultural hydrology, *Marshes, *France, Soil water table, Root zone, Agricultural hydrology, Soil-water-plant relationships, Nitrogen, Plant growth.

The watertable in winter depends on the field drainage system and the structural stability of the soils. The yield of winter wheat and the nitrogen supply of the soil are positively correlated with a lower watertable. Therefore, the mean watertable in winter is a good environmental indicator for the yield potentialities. For the explanation of yield variations, the depth of the root system was observed at the start of stem elongation and the anthesis. At the start of stem elongation, the root depth (E sub i) increases with a lower watertable in winter ($r = 0.931$). The root depth after anthesis (E sub f) depends on the root depth at stem elongation (E sub i) and on the climatic balance R (rainfall) minus ET (evapotranspiration) between these two stages. For $R > ET$, $R = ET$ and $R < ET$, root growth ($dE = E$ sub f minus E sub i) is respectively almost zero, decreases with increasing E sub i ('growth of roots making up for lost time') or increases with increasing E sub i ('homothetic growth'). The root depth studies explain the relation between the pedoclimatic and environmental conditions and the yield of winter wheat. (Author's abstract)
W89-05110

DRAINAGE BENEFITS: WATERTABLE CONTROL, WORKABILITY AND CROP YIELDS,
Ministry of Agriculture, Fisheries and Food, Cambridge (England). Field Drainage Experimental Unit.
For primary bibliographic entry see Field 4A.
W89-05111

DRAINAGE AND CROP PRODUCTION SYSTEM ON INTENSIVE DAIRY FARMS IN WESTERN FRANCE,
Centre National du Machinisme Agricole, du Genie Rural, des Eaux et des Forets, Antony (France).
For primary bibliographic entry see Field 4A.
W89-05113

EFFECT OF SWELLING AND SHRINKAGE ON THE CALCULATION OF WATER BALANCE AND WATER TRANSPORT IN CLAY SOILS,
Institute for Land and Water Management Research, Wageningen (Netherlands).
For primary bibliographic entry see Field 2G.
W89-05125

WATER CONSERVATION,
Agricultural Research Service, Phoenix, AZ. Water Conservation Lab.
H. Bouwer.
Agricultural Water Management AWMADF, Vol. 14, No. 1-4, p 233-241, August 1988.

Descriptors: *Irrigation practices, *Water yield improvement, *Irrigation effects, *Water Conservation, *Water management, Evaporation control, Evapotranspiration control, Cloud seeding,

Groundwater recharge, Water reuse, Drought, Water quality control.

Water conservation is the minimization of the transfer of water to a place or condition which diminishes its usefulness for the intended user. Water conservation can be achieved by reducing evaporation, transpiration, and quality degradation; and by cloud seeding, enhancing groundwater recharge, and treating and reusing sewage or other contaminated water. Evaporation can be minimized by irrigation efficiency and scheduling, altering cropping patterns, and using antitranspirants. In water-short areas, there usually is no single solution for solving problems of inadequate water supplies. Rather, a broad approach is needed, saving water, using water more efficiently, and reusing water wherever possible. Arid and semi-arid regions often have widely fluctuating seasonal or annual rainfall. The best time to prepare for droughts is during wet periods. (Author's abstract)
W89-05129

WATER HARVESTING STRATEGIES IN THE SEMIARID CLIMATE OF SOUTHEASTERN SPAIN,
Instituto Nacional de Investigaciones Agrarias, Cordoba (Spain).
For primary bibliographic entry see Field 4A.
W89-05131

PROSPECTS OF SOIL MOISTURE CONSERVATION BY FALLOWING IN AREAS OF MEDIUM AGRICULTURAL POTENTIAL IN SMALLHOLDER FARMING,
National Agricultural Labs., Nairobi (Kenya).
C. M. Njihia.
Agricultural Water Management AWMADF, Vol. 14, No. 1-4, p 265-275, August 1988. 5 fig, 5 tab, 8 ref.

Descriptors: *Soil water, *Soil moisture retention, *Fallowing, *Kenya, *Semiarid climates, *Agricultural hydrology, Soil-water-plant relationships, Farming, Dry farming, Crop yield.

The medium agricultural potential areas are characterized by low and unreliable rainfall with a drought period of variable length between the rainy seasons. Rainfall is frequently inadequate resulting in crop failure in some years underlining the importance of soil moisture conservation as a means of ensuring a crop. These medium potential areas are located largely north and south of the equatorial belt. In Kenya research has shown benefits of a clean fallow on moisture conservation and increased yields. However, efficiency of moisture storage was low resulting in substantial water loss in the top 60 cm, below which soil moisture was at about 1 bar suction. In another study benefits of a clean fallow soon after wheat harvest proved beneficial by conserving soil moisture and increasing wheat yields of the next crop. Despite the inefficiency of soil moisture storage the benefits of fallowing on yields are evident as moisture is the main determinant of yield in each season, but the farmers have been reluctant to adopt the practice. The reasons for this may be economic. The amount of water lost through evaporation from the clean fallow is sufficient to produce a short-season, low water demanding crop. The crop should preferably be shallow rooted to exploit moisture in the top 40-60 cm that is lost even under clean fallow conditions. A thus-cropped fallow would be an attractive alternative to a clean fallow, particularly to small scale farmers. (Author's abstract)
W89-05132

EFFECT OF WATER CONSERVATION ON THE YIELD OF UPLAND CROPS IN THE HUMID TROPICS,
Ghent Rijksuniversiteit (Belgium). Dept. of Soil Physics.
H. Verplancke, G. Maesschalck, and M. De Boodt.
Agricultural Water Management AWMADF, Vol. 14, No. 1-4, p 277-286, August 1988. 5 tab, 8 ref.

Descriptors: *Mulching, *Tropical regions, *Soil moisture retention, *Soil-water-plant relationships, *Crop yield, *Water use efficiency, Soil water, Agricultural hydrology, Malaysia, Dry farming.

The high variability of the rainfall in the humid tropics, with consequential excess or deficit of soil water determines the cropping patterns. It is also a major factor limiting the level of productivity of annual food crops. Experiments were performed in Malaysia aimed at a more intensive food crop production system not leading to increased erosion. Investigated was the effect of mulching on water use, water use efficiency and yield for various annual crops. Water balance experiments utilizing the internal drainage method were used to measure accurate values of unsaturated hydraulic conductivity to determine soil water fluxes. Average water consumption over the entire growing periods was found to be 3.01, 3.61, 2.96 and 4.05 mm/day for maize, mungbean, cowpea and chili respectively. The beneficial effect of mulching was proven in all the experiments. Rates of the three tons/ha are recommended as they improve the yield of all crops tested and increase their water use efficiency by as much as 90%. (Author's abstract)
W89-05133

PREDICTION OF IRRIGATION SCHEDULING WITH THE NUMERICAL MODEL SWATRE,
Institute for Land and Water Management Research, Wageningen (Netherlands).
J. G. Kesseling, and B. J. van den Broek.
Agricultural Water Management AWMADF, Vol. 14, No. 1-4, p 299-306, August 1988. 6 fig, 10 ref.

Descriptors: *Model studies, *Irrigation efficiency, *Mathematical models, *Agricultural hydrology, *Irrigation requirements, Hydrologic models, Hydrologic budget, Farm management.

The high intensity rate in agriculture and horticulture causes the need to re-evaluate irrigation practices. The present rate at which farmers irrigate may not yield the highest possible efficiency. In this paper we describe how the numerical model SWATRE (Soil-Water-Actual-Transpiration-Extended) can be used to predict the time of irrigation. This prediction is based on the assumption that the meteorological conditions do not change over the next 5 days. At the end of this 5-day forecasting period the predicted results are adjusted with the actual meteorological data. Data used to simulate the water balance are soil physical data, daily values of reference evapotranspiration and precipitation and weekly values of soil cover, rooting depth and groundwater level. Results indicate that with correctly measured and applied data the model may be a useful tool in current research to obtain better irrigation scheduling. (Author's abstract)
W89-05135

INFLUENCE OF SUB-SOIL ON THE MOISTURE REGIME IN IRRIGATED FIELDS,
Southampton Univ. (England). Inst. of Irrigation Studies.
For primary bibliographic entry see Field 2G.
W89-05136

IRRIGATION, GROUNDWATER ABSTRACTION AND STREAM FLOW DEPLETION,
Danish Land Development Service, Viborg. Research Dept.
H. Madsen.
Agricultural Water Management AWMADF, Vol. 14, No. 1-4, p 345-354, August 1988. 9 fig, 6 ref.

Descriptors: *Groundwater irrigation, *Agricultural hydrology, *Streamflow depletion, *Surface-groundwater relations, *Hydrologic models, Statistical analysis, Model testing, Irrigation, Theis-Jenkins model, Aquatic habitats.

In Denmark, permission to abstract groundwater for field irrigation can be denied in case of a potential risk of reducing the streamflow below the recommended minimum. Reduction in stream flow is unacceptable as it creates an unsuitable habitat for such fish as salmon. Analytical, statistical and numerical models have been tested for inestigating streamflow depletion and the results are compared with the actual streamflow depletion measured for 3 small streams in western Jutland. In general, the analytical models are not ideal for verifying the influence of existing wells on stream depletion, but they are suitable as a prognostic tool for estimating the influence of new wells on stream flow depletion. Findings also show that the Theis-Jenkins model which neglects resistances near the stream often overestimates the stream flow depletion. (Author's abstract)
W89-05140

IMPORTANCE OF HYDROLOGICAL RESEARCH IN DESIGNING RURAL WATER MANAGEMENT SYSTEMS AS PART OF LAND DEVELOPMENT PROJECTS IN THE NETHERLANDS,
Institute for Land and Water Management Research, Wageningen (Netherlands).
H. Prak.
Agricultural Water Management AWMADF, Vol. 14, No. 1-4, p 365-375, August 1988. 6 fig, 16 ref.

Descriptors: *Agricultural hydrology, *Hydrology, *Water management, *Rural areas, *Land development, *Water resources development, *The Netherlands, Research Priorities, Water quality management, Management planning, Drainage, Groundwater management.

In the past, land consolidation projects in the Netherlands were designed almost exclusively to increase crop yields and farm income. Also the improvement of the water management system served agricultural purposes. Hydrological research, therefore, was directed to find optimal agro-hydrological conditions. The results were translated into criteria for hydrological variables (like groundwater and surface water levels, discharge coefficients) and design rules for subsurface drainage systems. Initially the need to reduce excessive wetness was emphasized, later yield reduction due to water shortages in summer also became important. Lately the land consolidation projects have been renamed as 'land development projects'. This is a result of recent developments in the rural areas, where aspects of nature conservation and outdoor recreation have become important items. Because water management measures in favor of one function often interfere with another, fixed design rules are no longer sufficient. The hydrological consequences for different interests have to be known beforehand. For the calculations of groundwater flow, analytical solutions are being replaced by numerical methods in order to cope with increasingly complex situations. Aspects of water quality are becoming more important. In addition to analyses of water samples, attention is paid to flow paths and stream velocities of groundwater, which give insight into the relation between quality and quantity. In this work, a close cooperation with agronomists and biologists has been established. A review is given of the hydrological models used for this purpose, at present and in the near future. (Author's abstract)
W89-05142

OPERATIONAL ASPECTS OF SURFACE WATER MANAGEMENT IN RELATION TO THE HYDROLOGY OF AGRICULTURAL AREAS AND NATURE RESERVES,
Institute for Land and Water Management Research, Wageningen (Netherlands).
P. J. T. van Bakel.
Agricultural Water Management AWMADF, Vol. 14, No. 1-4, p 377-387, August 1988. 5 fig, 3 tab, 6 ref.

Descriptors: *Agricultural hydrology, *Hydrology, *Water management, *The Netherlands, *Regional planning, *Hydrologic models, Parks, Simulation analysis, Soil water table, Groundwater level, Adminstrative agencies.

In the Netherlands, water boards are responsible for the surface water management. They try to fulfill mainly the agricultural demands by improving the drainage conditions in wet periods (by lowering the surface water levels) and sometimes by raising the surface water levels in dry periods during the growing season. This type of operation is based on practical experience. A more systemat-

ic approach is presented that yields better results. This approach prescribes the way to react upon changes in groundwater levels and soil water status. Nature reserves are influenced by the operation of the surface water system in neighboring agricultural areas. The possible mutual influence is illustrated with an integrated model for the regional groundwater flow, the flow of water in the unsaturated zone and the surface water system. On basis of the results of three case studies, it is concluded that surface water management is an effective means to improve the hydrological conditions in both agricultural areas and nature reserves. To realize this improvement a systematic approach using simulation models is very helpful. (Author's abstract)
W89-05143

HYDROLOGICAL RESEARCH AND THE DESIGN OF A WATER MANAGEMENT SYSTEM FOR A PEATLAND AREA WITH AGRICULTURE AND NATURE IN THE LAND CONSOLIDATION PROJECT: ECHTENER AND GROOTE VEENPOLDER,
Institute for Land and Water Management Research, Wageningen (Netherlands).
J. M. L. Jansen.
Agricultural Water Management AWMADF, Vol. 14, No. 1-4, p 389-397, August 1988. 6 fig, 1 tab, 5 ref.

Descriptors: *Hydrology, *Agricultural hydrology, *Drainage, *Water management, *Land development, *Peat soils, *The Netherlands, *Groundwater flow, Management planning, Case studies, Hydrological regime, Hydrologic models.

The national land consolidation policy for low lying peatland areas in the Netherlands aims at agricultural development as well as the development of natural values. Because both forms of land use strongly depend on hydrological conditions, the design of the water management system requires hydrological research that includes both water quantity and water quality aspects. The paper describes a case study of the Rottige Meente, a part of the land consolidation project Echtener and Groote Veenpolder, which covers about 7700 ha in the North of the Netherlands. A quantitative description is given of the hydrological regime and its relation to water quality, based on field inventories and STATRECT, a numerical simulation model for groundwater flow. It is shown how this knowledge was used in the formulation of the potentials of the area with regard to nature development. The changes in the water balance that were caused by the reclamation of the low lying North East Polder, west of the project area, appeared to be of decisive importance. (Author's abstract)
W89-05144

FORECASTING THE SUITABILITY OF PUMPED GROUNDWATER FOR IRRIGATION IN THE NILE VALLEY,
Iwaco B.V., Rotterdam (Netherlands).
A. B. M. Lennaerts, F. A. R. Attia, and S. J. de Jong.
Agricultural Water Management AWMADF, Vol. 14, No. 1-4, p 525-535, August 1988. 4 fig, 4 tab, 9 ref.

Descriptors: *Groundwater irrigation, *Egypt, *Nile valley, *Irrigation, Water table, Salinity, Water quality, Feasibility studies, Hydrologic models, Evapotranspiration, Calcium, Nitrates, Sulfates, Sodium, Forecasting.

Both the quantitative and qualitative environmental side effects were taken into account in a technical and economic feasibility study of groundwater pumping strategies in Minya pilot area, Egypt. The major qualitative environmental side effect is related to the groundwater quality itself. The pumping of groundwater and the subsequent use as irrigation water will cause changes in the groundwater quality in space and time. The major change in chemical composition of the irrigation water occurs in the soil due to concentration of salts by evapotranspiration. The main reactions are calcite precipitation, cation exchange, weathering of clay minerals and reduction of sulfates and nitrates. A forecast of the water quality is made with hydrochemical models including the solute transport package STIWACO. Calculations show that in a 100-year period following the start of pumping, the total dissolved solids and the sodium adsorption ratio of the pumped groundwater increases from 530 to about 700 ppm, and from 4 to 6 respectively. The suitability for irrigation of the pumped groundwater is evaluated with recent FAO guidelines. According to these guidelines, no water quality problems are expected when groundwater is used for irrigation. (Author's abstract)
W89-05154

WATER TABLE CONTROL, REUSE AND DISPOSAL OF DRAINAGE WATER IN HARYANA,
Euroconsult, Arnhem (Netherlands).
J. H. Boumans, J. W. van Hoorn, G. P. Kruseman, and B. S. Tanwar.
Agricultural Water Management AWMADF, Vol. 14, No. 1-4, p 537-545, August 1988. 3 fig, 1 tab, 1 ref.

Descriptors: *Water reuse, *Drainage water, *India, *Water table rise, *Irrigation, *Drainage effects, Saline water, Subsurface drainage, Brackish water, Drainage, Feasibility studies.

In the state of Haryana in northwestern India, the water table in a large area underlain by brackish and saline groundwater is rising, owing to percolation losses from irrigation. A study was made of the water table rise to be expected in the future, its agroeconomic consequences and the technical solutions for water table control, including reuse and disposal of drainage water. To minimize the salt load caused by the drainage water, the water table should be controlled by horizontal subsurface drains or by shallow, vertical, skimming wells. Although brackish and saline water can be used for salt extraction and for fish culture as well as for irrigation, the use of saline groundwater for salt production and for fish culture is very limited. Since the recycling of brackish and saline drainage water within the irrigated area will ultimately lead to an increase in salt concentration of the irrigation water and the soil, disposal by an outfall drain to the sea was considered as a long-term solution. A feasibility study to evacuate 12.5 cu m/s required a 450-km outfall drain to the Luni river. The water would have to be lifted about 100 m over mountains by pumping resulting in a high cost/ha. However, as agricultural production and land value rise, this solution may prove to be economically feasible in the future. (Vernooy-PTT)
W89-05155

INDEX FOR MEASURING THE PERFORMANCE OF IRRIGATION MANAGEMENT SYSTEMS WITH AN APPLICATION,
Colorado State Univ., Fort Collins. Dept. of Agricultural and Natural Resource Economics.
D. Seckler, R. K. Sampath, and S. K. Raheja.
Water Resources Bulletin WARBAQ, Vol. 24, No. 4, p 855-860, August 1988. 1 tab, 11 ref.

Descriptors: *Irrigation, *Irrigation efficiency, *Performance evaluation, *Water management, *Theil index, *Agricultural hydrology, India, Irrigation water, Farming, Agriculture, Evaluations.

The Theil Index is a statistically valid index for measuring the performance of irrigation systems is presented. The index was applied to a sample of 39 farms on a watercourse under the warabandi system of irrigation management in India, which is based on fixed rotations of water delivery between areas and farms. It was found that while the farmers in fact irrigated almost exactly the total amount of irrigated area as designed, inter-farm variations were considerable. The index shows that the degree of error of managerial effectiveness of irrigation on this watercourse is 20%. Therefore it is concluded that the system is performing at 80% effectiveness. The index not only measures the performance of a given system but it can also provide a consistent means of comparing the performance of different systems as long as the systems have explicit and quantifiable objective functions. (Freemann-PTT)
W89-05276

OPTIMIZING THE RETURN FROM A JOJOBA PLANTATION UNDER SCARCE DATA CONDITIONS,
Dead Sea Works, Beersheba (Israel).
D. Wisniak. and G. Oron.
Water Resources Bulletin WARBAQ, Vol. 24, No. 4, p 879-886, August 1988. 4 fig, 2 tab, 12 ref.

Descriptors: *Water requirements, *Irrigation requirements, *Optimization, *Agriculture, *Fertilizers, *Profit, *Optimal yield, *Computer models, Jojoba, Economic aspects, Input-output analysis, Value, Economic yield.

There is a serious shortage of yield data for Jojoba (Simmondsia chinensis) from mature and cultivated plantations of ten years or older. Thus, the optimal quantities of water and fertilizers that are needed annually by a Jojoba plantation to achieve maximum profits were estimated from existing plantations. A computer model (IMSL subroutine ZXMWD) was used to determine a Mitscherlich yield function. An economic profit model that incorporates the yield function was then designed to maximize the profits. According to the net present value (NPV) criterion, the maximum yearly net profit is about $7800 per ha, which is achieved during the 11th growth year. The computed cumulative NPV is approximately $21,000 per ha for the entire 15-yr period. Similar profits were calculated when the model was tested to examine the NPV using different assumptions with respect to varying costs. (Author's abstract)
W89-05279

IRRIGATION MANAGEMENT PROJECT START-UP WORKSHOP IN NEPAL, SEPTEMBER 2 TO 5, 1986,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
J. J. Pettit.
Water and Sanitation for Health Project Field Report No. 196, October 1986. 72p, 1 fig, 1 tab, 6 append. AID Contract 5942-C-00-4085-00, Project 936-5942.

Descriptors: *Irrigation practices, *Management planning, *Nepal, *Developing countries, Irrigation, Water management, Water use, Irrigation programs, Irrigation districts.

The Water and Sanitation for Health (WASH) Project assisted USAID/Nepal in planning and implementing a project start-up workshop for the new Irrigation Management Project (IMP). The primary goal of the project is to increase the capability of the Department of Irrigation, Hydrology, and Meteorolgy (DIHM) for managing government-operated irrigation systems. The workshop resulted in a series of general and specific outcomes, which include: better understanding of the background and reasons for IMP; clarity concerning roles and responsibilities; agreement on project management issues among DIHM, USAID, and the contractor team; agreement on a series of critical project issues, such as staffing requirements during startup and integration of the technical and institutional development aspects; work plans for the various areas of the project, including operations and maintenance, water users' associations, the irrigation and management center, and USAID project support activities. Recommendations includes a variety of suggestions for maintaining the momentum created by the workshop. These include quarterly reviews of project management: weekly or biweekly meetings for the first six months; yearly planning meetings, such as this workshop; and use of various communications mechanisms to keep project staff apprised of plans, problems, and accomplishments. (Lantz-PTT)
W89-05377

WATER REQUIRED, WATER USED, AND POTENTIAL WATER SOURCES FOR RICE IRRIGATION, NORTH COAST OF PUERTO RICO,
Geological Survey, San Juan, PR. Water Resources Div.

A. J. Roman-Mas.
Water-Resources Investigations Report 86-4334, 1988. 35p, 15 fig, 11 tab, 19 ref.

Descriptors: *Irrigation, *Water use, *Water requirements, *Puerto Rico, Rice, Water resources development, Agriculture, Rainfall, Seasonal variation, Aquifers, Saline water intrusion.

A 3-yr investigation was conducted to determine the water required and used (both consumed and applied) for irrigation in the rice-growing areas of Vega Baja, Manati, and Arecibo along the north coast. In addition, the investigation evaluated the water resources of each area with regard to the full development of rice farming areas. Based on experiments conducted at selected test farms, water required ranged from 3.13 to 5.25 acre-ft/acre/crop. The amount of water required varies with the wet and dry seasons. Rainfall was capable of supplying from 31 to 70% of the water required for the measured crop cycles. Statistical analyses demonstrated that as much as 95% of rainfall is potentially usable for rice irrigation. The amount of water consumed differed from the quantity required at selected test farms. The difference between the amount of water consumed and that required was due to unaccounted losses or gains, seepage to and from the irrigation and drainage canals, and lateral leakage through levees. Due to poor water-management practices, the amount of water applied to the farms was considerably larger than the sum of the water requirement and the unaccounted losses or gains. Rivers within the rice growing areas constitute the major water supply for rice irrigation. Full development of these areas will require more water than the rivers can supply. Efficient use of rainfall can significantly reduce the water demand from streamflow. The resulting water demand, however, would still be in excess of the amount available from streamflow. Groundwater development in the area is limited because of seawater intrusion in the aquifers underlying the rice-growing areas. Capture of seepage to the aquifers using wells located near streams, artificial recharge, and development of the deep artesian system can provide additional water for rice irrigation. (Author's abstract)
W89-05407

WINNING WITH WATER: SOIL-MOISTURE MONITORING FOR EFFICIENT IRRIGATION,
INFORM, Inc., New York.
G. Richardson, and P. Mueller-Beilschmidt.
INFORM, Inc., New York. 1988. 173p.

Descriptors: *Soil moisture meters, *Soil moisture monitoring, *Soil water potential, *Irrigation efficiency, *Monitoring, *Irrigation practices, Agriculture, Crops, Agricultural hydrology, Irrigation design, Flood irrigation.

Overwatering of crops adds to costly problems of yield damage, drainage buildup, salinity and pollution of groundwater and surface streams. Each field's soil types and conditions are unique and pose different puzzles of irrigation management. In addition, weather and water supply conditions change each year, and everything farmers do to fields, from plowing to harvesting, affects and is affected by, their irrigation practices. The method of soil moisture monitoring with gypsum blocks that INFORM has demonstrated since 1984 gives farmers a reliable way to find the right questions to ask about their irrigation practices on each field. It shows them where they underwater or overwater field sections so they can test and improve their irrigation practices to reduce these problems. It enables them to track water use by crops between irrigations and plan their irrigation schedules efficiently. By observing changes in soil moisture levels, farmers can learn where their roots are deep and active or where they are shallow and cramped. This soil moisture method is inexpensive, easy to learn and flexible. Farmers can adapt it at their own pace to their own needs. The method does not add a new set of tasks to a farmer's already long list of field responsibilities. Rather it gives farmers a systematic way to use more efficiently their pumps, pipelines, hydrants, ditches, siphons, fertilizers, pesticides, labor and machinery to achieve the overall goal of farming - high yields. The soil moisture method tested by INFORM is designed especially for use of fields irrigated by flooding all or part of field surfaces. These fields constitute about three-quarters of the West's irrigated acreage. If farmers managing these fields adopted the soil-moisture method of irrigation management, then soils and crops, farmers and non-farmers alike would greatly benefit. (Lantz-PTT)
W89-05542

WATER EROSION IN THE DRYLAND CROPPING REGIONS OF AUSTRALIA: 5. LAND AND LAND USE DATA FOR A RELATIVE ASSESSMENT OF POTENTIAL SOIL MOVEMENT IN WESTERN AUSTRALIA,
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
For primary bibliographic entry see Field 2J.
W89-05758

ECONOMIC STUDY FOR THE POTENTIAL FOR WATER MARKETS IN IDAHO,
Washington State Univ., Pullman. Dept. of Agricultural Economics.
For primary bibliographic entry see Field 6B.
W89-05777

4. WATER QUANTITY MANAGEMENT AND CONTROL

4A. Control Of Water On The Surface

WETLAND CONSERVATION IN FINLAND,
Ministry of the Environment, Helsinki (Finland).
For primary bibliographic entry see Field 2H.
W89-04691

MULTIOBJECTIVE APPROACH TO WATER MANAGEMENT SYSTEM FOR WETLANDS IN BIEBRZA RIVER VALLEY: CASE STUDY,
Institute for Land Reclamation and Grassland Farming, Raszyn (Poland).
For primary bibliographic entry see Field 2H.
W89-04692

DITCH CLEANING AND ADDITIONAL DITCHING IN PEATLAND FORESTRY: EFFECT ON GROUND WATER LEVEL,
Helsinki Univ. (Finland). Dept. of Peatland Forestry.
J. Paivanen, and E. Ahti.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu, Finland, 6-8 June 1988. Vol. 1. The Academy of Finland, Helsinki, Finland. 1988. p 184-189, 5 fig, 1 tab, 6 ref.

Descriptors: *Wetlands, *Drainage ditches, *Peat bogs, *Water table fluctuations, *Forestry, *Environmental effects, Drainage practices, Finland, Hydrologic budget, Base flow, Runoff.

Water table reactions to ditch cleaning and additional ditching in peatland sites earlier drained for forestry are reported. On the average, additional ditching proved to be slightly more effective than ditch cleaning. In this respect, however, the variation between the 10 field experiments examined was considerable. The effects of the two treatments appeared to be more or less additive. This can be explained by the fact that the two treatments have different influences on the water balance: ditch cleaning, or making the ditches deeper, increases base flow occurring deeper in the profile, as additional ditching tends to increase the peak flows occurring in the surface peat layers immediately after rainfall or snowmelt. As a whole, the water table reactions were rather limited. This might be partly because experimental sites were chosen in which the stands were well developed enough to maintain favorable moisture conditions through interception and transpiration in spite of a poor ditch network. The differences in pretreatment water status between individual plots could not be fully eliminated by using a calibration period and control plot design. (See also W89-04689) (Author's abstract)
W89-04715

PRELIMINARY RESULTS OF A MOLE DRAINAGE EXPERIMENT IN PIIPSANNEVA PEAT HARVESTING SITE,
Vapo Oy, Jyvaskyla (Finland).
V. Klemetti, A. Scholz, P. Selin, and T. Nyronen.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu, Finland, 6-8 June 1988. Vol. 1. The Academy of Finland, Helsinki, Finland. 1988. p 277-284, 2 fig, 1 tab, 12 ref.

Descriptors: *Mole drainage, *Wetlands, *Drainage effects, *Peat bogs, *Water table fluctuations, *Drainage practices, Nitrogen, Alkalinity, Organic matter, Environmental effects, Suspended solids, Water quality, Water pollution prevention, Finland.

Testing of the suitability of mole drainage for the draining of the Finnish peat harvesting mires was started in Piipsanneva harvesting site in August 1987. A total of 71 drains were made parallel with the open ditches. Their total length exceeded 40 kilometers, while the longest individual drains were more than 600 meters long. The monitoring program included measurement of the flow rates from each drain and the groundwater table at different distances from the drains as well as the water analyses. Our preliminary results show that the mole drains can work intensively in the peat layer. The recorded fluctuation in the flow rates and groundwater table can be considered as an evidence of the infiltration of the rain water through the peat layer to the drains. At first the color of runoffs was very dark, the alkalinity quite high and the concentration of dissolved organic matter and iron quite high. Later the water was nearly colorless. The load of total nitrogen was nearly normal during the frost free season; about 90% of the total compounds were in ammonia. After a week the load of dissolved phosphorus was lower than normal during the summer. The mole drain system clearly decreases the load of suspended solids and the environmental effects of peat production. The first results can be considered hydrologically and environmentally promising. The coming years will show whether the method fulfills economical requirements as well. (See also W89-04689) (Author's abstract)
W89-04725

STABILITY DESIGN OF GRASS-LINED OPEN CHANNELS,
Agricultural Research Service, Stillwater, OK. Plant Science and Water Conservation Lab.
For primary bibliographic entry see Field 4D.
W89-04849

TECHNIQUES FOR SIMULATING FLOOD HYDROGRAPHS AND ESTIMATING FLOOD VOLUMES FOR UNGAGED BASINS IN CENTRAL TENNESSEE,
Geological Survey, Nashville, TN. Water Resources Div.
For primary bibliographic entry see Field 2E.
W89-04955

EFFECTS OF WEED CONTROL ON SPECIES COMPOSITION OF AQUATIC PLANTS AND BANK PLANTS AND MACROFAUNA IN DITCHES,
Utrecht Rijksuniversiteit (Netherlands). Dept. of Plant Ecology.
B. Beltman.
Hydrobiological Bulletin HYBUD9, Vol. 21, No. 2, p 171-179, December 1987. 2 fig, 5 tab, 24 ref.

Descriptors: *Ditches, *Polders, *Aquatic weed control, *Aquatic plants, *Macroinvertebrates,

Species composition, Floating plants, Submerged plants, Algae, The Netherlands, Elodea.

For several years, the effect of ditch management measures on the species composition of aquatic and bank flora and macrofauna were studied in a polder with a peat soil. The mowing basket increased the presence of floating plants whereas the ditch-scoop increased filamentous algae and submerged plant species. Monospecific stands of aquatic plants had fewer macrofaunal species than stands with many plant species. Many of the effects of ditch cleaning methods on macrofauna act via the vegetation. Water plants provide the fauna with opportunities for grazing, shelter, spawning, pupation, etc. Because aquatic plants intertwiene strongly during their growth and fauna species disperse, correlations between macrofauna and plants can not easily be demonstrated in the field. Although the macroinvertebrates are influenced directly, the remnants of the vegetation gave shelter to most of the species (though just a few individuals of each species). The following hypothesis is proposed. If the weed control takes place during the growing season the flux of nutrients released from the sediment and the decaying plants is used by fast growing aquatic plants (Elodea spp. and Callitriche spp.) or algae. In this way an impoverishing effect of the ditch cleaning on the species composition of the aquatic plants and the macrofauna can be recognized. (Author's abstract)
W89-05041

USING EXOGENOUS VARIABLES IN TESTING FOR MONOTONIC TRENDS IN HYDROLOGIC TIME SERIES,
Geological Survey, Reston, VA.
For primary bibliographic entry see Field 2A.
W89-05065

USE OF CHANGE CONSTRAINTS IN RESERVOIR DESIGN AND OPERATION MODELING,
Wright State Univ., Dayton, OH. Dept. of Geology.
H. A. Loaiciga.
Water Resources Research WRERAO, Vol. 24, No. 11, p 1969-1975, November 1988. 1 fig, 16 ref. 2 append.

Descriptors: *Reservoir design, *Reservoir modeling, Mathematical models, Feasibility studies, Model studies, Reservoir operation, Planning, Standards.

This work examines (1) the set of probabilistic and deterministic constraints binding the objective function of a reservoir design and operation problem, (2) the conditions under which the solution of a reservoir design and operation problem becomes infeasible, and (3) the discrepancies between the exact chance constrained formulation of the reservoir design and operation problem and alternative models. Chance-constrained feasibility sets that restrict reservoir levels to be within zero and maximum capacity with probability one are differentiated from those sets that impose a less stringent chance constraint on reservoir levels. The probability is derived that a reservoir solution computed with the less stringent feasibility set is physically feasible (i.e. reservoir levels are bounded by zero and reservoir capacity). Such probability is a function of prespecified reliability levels, the length of the planning horizon, the joint distribution of streamflows and initial reservoir storage, reservoir capacity, and two chance-constrained parameters. Physically feasible solutions yielded by alternative models are valuable if they serve as guidelines that are updated (as they are implemented) in response to unforseen, uncontrollable events. (Author's abstract)
W89-05067

EFFECTS OF DRAINAGE ON CROPS AND FARM MANAGEMENT,
Institute for Land and Water Management Research, Wageningen (Netherlands).
For primary bibliographic entry see Field 4C.
W89-05107

EFFECTS OF SUBSURFACE DRAINAGE ON HEAVY HYDROMORPHIC SOIL IN THE NELINDVOR AREA, YUGOSLAVIA,
Institut za Vodoprivredu Jaroslav Cerni, Belgrade (Yugoslavia).
For primary bibliographic entry see Field 4C.
W89-05108

DRAINAGE BENEFITS: WATERTABLE CONTROL, WORKABILITY AND CROP YIELDS,
Ministry of Agriculture, Fisheries and Food, Cambridge (England). Field Drainage Experimental Unit.
A. C. Armstrong, J. G. Rands, and D. A. Castle.
Agricultural Water Management AWMADF, Vol. 14, No. 1-4, p 43-52, August 1988. 3 fig, 4 tab, 10 ref.

Descriptors: *Groundwater management, *Agricultural hydrology, *Drainage effects, *Soil water table, *Crop yield, *Water table, Great Britain, Soil water, Soil-water-plant relationships, Data collections, Drainage, Economic evaluation, Investment.

Data are presented from a survey of over 200 sites in England and Wales, which record soil water regimes and ground conditions on paired drained and undrained areas. Despite great variability in the level of benefit achieved, drainage can increase the length of the working season by three weeks in both spring and autumn. Crop yield data show drainage effects that also vary from year to year. Because of these large variations, it is possible to evaluate the benefits of drainage only in the long term. It would be unwise to make a straight economic evaluation on a simple mean crop yield benefit. Rather the calculation should be based on a consideration of the whole farm context within which the investment will be made. (Author's abstract)
W89-05111

FRENCH PROGRAMME OF DRAINAGE REFERENCE AREAS: METHODOLOGY AND FIRST RESULTS,
Centre National du Machinisme Agricole, du Genie Rural, des Eaux et des Forets, Antony (France).
P. Jannot, and D. Schnabele.
Agricultural Water Management AWMADF, Vol. 14, No. 1-4, p 53-60, August 1988. 2 fig, 2 tab, 7 ref.

Descriptors: *Agricultural hydrology, *Drainage programs, *Soil management, *Drainage practices, *Soil surveys, *France, Farm management, Soil water table, Soil water, Drainage, Waterlogging, Crop production, Weather, Investment.

The French Programme of Drainage Reference Areas is aiming at developing drainage in French farms. As drainage involves high investments, farmers have to be provided with all the technological, agronomic and economic information required to improve waterlogged lands. The program is threefold. Soil surveys are carried out for a small area (500 to 1500 ha) in order to determine the best drainage method. Then main collectors and open channels are made. Lastly, conditions under which farms of this area can get the best results from drainage are studied. Examples from two different regions show that, whatever the constraints due to excess water, drainage investment can only be planned for some farm types characterized by their history, current crop production system and prospects. Drainage sometimes appears to be essential for developing or stabilizing a crop production system which is now too dependent on weather conditions. (Author's abstract)
W89-05112

DRAINAGE AND CROP PRODUCTION SYSTEM ON INTENSIVE DAIRY FARMS IN WESTERN FRANCE,
Centre National du Machinisme Agricole, du Genie Rural, des Eaux et des Forets, Antony (France).
P. Jannot.
Agricultural Water Management AWMADF, Vol. 14, No. 1-4, p 61-68, August 1988. 2 fig, 7 tab, 7 ref.

Descriptors: *Crop production, *Agricultural hydrology, *Farms, *Dairy industry, *France, *Drainage programs, *Drainage systems, Farm management, Crop yield, Soil water table, Marine climates, Waterlogging, Farming, Cultivation, Pastures, Crop production, Corn, Grasslands.

In Western France the mild, humid oceanic climatic prevailing in this region is favorable for the growth of grass and there are many dairy farms. The intensification of milk production has led to an increased area of maize and temporary grassland for making silage and a decrease of permanent pastures. However, the intensification is hampered by the frequent waterlogging of many soils. Within the framework of 'Drainage Program of Sample Areas' the effects of drainage on labor organization were studied on dairy farms of 'l'Orne Saosnoise' located in the department of Sarthe. The farms are of medium size, about 40 hectares; the soils are wet; labor is provided by the family. Excess from October till May makes field operations in spring required for more intensive forage production very difficult. Observations were made on farms under a wide range of conditions. Three different farm types were identified. Some conventional farms drained a few hectares without changing the crop production system and the intensification level. The main aim is to get better conditions for early tillage operations. Some farms combine drainage with intensified dairy production. In such a case, drainage allows a new forage production system with a significant increase in the number of days required for field operations. Most of the drained farms carried out drainage after intensification of their diary unit. In such a case drainage improves the number of days available for operations whereas the number of days required remains almost the same since forage production had already been intensified. (Author's abstract)
W89-05113

WATERTABLE CONTROL INDICES FOR DRAINAGE OF AGRICULTURAL LAND IN HUMID CLIMATES,
Euroconsult, Arnhem (Netherlands).
L. K. Smedema.
Agricultural Water Management AWMADF, Vol. 14, No. 1-4, p 69-77, August 1988. 7 fig, 11 ref.

Descriptors: *Agricultural hydrology, *Groundwater management, *Cropland, *Drainage, *Humid climates, *Water table fluctuations, Soil water table, Drainage programs, Waterlogging, Crop yield.

Annual and seasonal watertable regimes of agricultural land have in many cases successfully been related to drainage objectives characterizing these regimes by such indices as average watertable depth, duration and frequencies of occurrence of high watertables, etc. In view of the complicated crop responses to waterlogging during the growing season, it would be difficult to compare the applicability of the three discussed water table control indices. All of the indices derive their meaning from their relationship with crop yield. For soil workability, watertable conditions during certain short periods in which critically important farm operations have to be completed, would be diagnostic. Relating watertable regime to net farm returns, the ultimate objective, by a single index, therefore, seems to be a vain hope. (Author's abstract)
W89-05114

AGRICULTURAL CRITERIA FOR SUBSURFACE DRAINAGE: A SYSTEMS ANALYSIS,
International Inst. for Land Reclamation and Improvement, Wageningen (Netherlands).
R. J. Oosterbaan.
Agricultural Water Management AWMADF, Vol. 14, No. 1-4, p 79-90, August 1988. 10 fig, 13 ref.

Descriptors: *System analysis, *Design criteria, *Subsurface drainage, *Agricultural hydrology, *Soil water table, *Drainage engineering, Water table fluctuations, Drain spacing, Indicators, Soil-water-plant relationships, Drainage, Hydrologic budget, Crop production, Statistical analysis.

The effects of subsurface drainage on agriculture are analyzed in relation to drain discharge, control of the watertable and salt evacuation. The drain discharge depends mainly on external factors (the water balance), whereas the level of the watertable can be influenced by the design of the drainage system. Agricultural drainage criteria must therefore be sought in the required degree of watertable control, given a certain water balance. To this end, relationships between watertable depth and crop production or production factors need to be determined, and critical depth values need to be derived. As the watertable fluctuates, a suitable indicator has to be found for it from the depth-duration-frequency relationship. The variable that gives the highest degree of statistical explanation is the most suitable. It can be a long-term, average depth, or an extreme, short-term, shallow depth. The corresponding agricultural drainage criteria are called long-term and short-term criteria. The first are associated with steady-state drain-spacing equations, the second with either steady-state or unsteady-state equations, depending on the ratio of storage to recharge or discharge. (Author's abstract)
W89-05115

DRAINAGE CRITERIA FOR HEAVY SOILS WITH A SHALLOW IMPERVIOUS LAYER,
Instituto Nacional de Reforma y Desarrollo Agrario, Madrid (Spain).
J. Martinez Beltran.
Agricultural Water Management AWMADF, Vol. 14, No. 1-4, p 91-96, August 1988. 4 fig, 2 tab, 6 ref.

Descriptors: *Drainage engineering, *Clay, *Impervious soils, *Drainage systems, *Subsurface drainage, *Soil water table, Spain, Soil water, Drawdown, Drainage.

Drainage criteria for heavy soils with a shallow impervious barrier are formulated. These criteria are based on the relationship between the draw down of the groundwater table and crop yields. The results shown in this paper present the experience obtained in Spain in draining saline heavy soils with a shallow impervious layer, mainly silty clay soils in the Ebro basin and clay soils in the Guadalquivir marshes. The benefit-cost ratio achieved shows the feasibility of subsurface drainage to reclaim such soils. (Author's abstract)
W89-05116

METHODS TO DETERMINE THE NEED FOR DRAINAGE IN FLAT AREAS,
Vizgazdalkodasi Tudomanyos Kutato Intezet, Budapest (Hungary).
N. Bagnar, and L. M. Toth.
Agricultural Water Management AWMADF, Vol. 14, No. 1-4, p 97-102, August 1988. 2 fig, 2 tab, 5 ref.

Descriptors: *Geohydrologic boundaries, *Drainage, *Drainage programs, *Soil water table, *Hydrologic data collections, Hungary, Water table, Water table fluctuations, Soil types, Groundwater level, Observation wells, Regional planning.

A method is developed for determining the boundaries of flat areas in Hungary, that are characterized by a deep aquifer and a shallow watertable and require drainage. The method is based on the long-term recordings of the national groundwater observation network. This paper presents the first results of the method by showing its use for drainage projects. Using the data of 12 observation wells, 5 monthly average groundwater levels were calculated, at 10, 20, 33, 50, and 90% probabilities. The boundaries of the area requiring drainage were then determined. The method is suitable for improving the preparation and quality of land drainage projects; providing useful information for preliminary efficiency calculations; and giving a good basis for the dialogues between the experts concerned. It also seems useful for the preparation of urban and industrial development plans, and for environmental studies concerning better protection against groundwater pollution. (Author's abstract)
W89-05117

WATER MANAGEMENT AND DRAINAGE DESIGN OF A SELECTED POLDER,
Gdansk Technical Univ. (Poland). Inst. of Hyrdotechnics.
P. J. Kowlik.
Agricultural Water Management AWMADF, Vol. 14, No. 1-4, p 103-112, August 1988. 6 fig, 13 ref.

Descriptors: *Grounwater management, *Drainage engineering, *Drainage, *Drainage systems, *Polders, Poland, Soil water table, Water management, Soil water, Hydrologic data collections, Rainfall distribution, Soil types.

The present state of water management of a selected polder in Poland is described. The polder 'Fiszewka S', with an area of 3620 ha, is located 0.0 to 1.5 m below sea level, and drained by one central pumping station. The area, its drainage conditions, rainfall, pumping intensities, and soil water content dynamics are summarized. The results presented indicate a considerable influence of the distribution of rains during the growing season and a small influence of the total cumulative rainfall for the whole summer. The simulation results showed that in the light sandy soil the difference between maximum and minimum water content in the upper meter of the soil profile was 70 mm. The same value was found for the dry year 1976 and for the wet year 1981. In the heavy silty soil the difference was 120 mm, again in both years. (Vernooy-PTT)
W89-05118

FIELD DRAINAGE AND LAND MANAGEMENT: A COMPARISON OF FOUR LONG TERM FIELD TRIALS,
Birkbeck Coll., London (England). Dept. of Geography.
A. M. Clark, A. C. Armstrong, R. J. Parkinson, and I. Reid.
Agricultural Water Management AWMADF, Vol. 14, No. 1-4, p 113-124, August 1988. 5 fig, 1 tab, 22 ref.

Descriptors: *Subsurface drainage, *Field tests, *Clays, *Hydrologic data collections, *Land management, *Agricultural hydrology, Soil water, Comparison studies, Soil types, Rainfall disposition, Groundwater movement, Permeability, Rain, Root zone, England, Drainage.

Hydrological data from four agricultural underdrainage installations in different clay series of the United Kingdom have been analyzed. The data record spans thirteen drainage seasons, with a total of twenty-nine data-years included. An analysis of 'simple' storms during the winter period when antecedent moisture conditions are comparatively uniform show significant differences in the route followed by rainwater on its way from the soil surface to the drain outfall. The initial drainage response of heavy clays is slow--on average 1.21 h later than a clay loam. However, once a routeway has been established, water travels most rapidly in the heaviest soil, drainage taking 2.5 h to reach peak discharge compared with 5.0 h in the lightest soil. An explanation for this difference is found in the fraction of rainfall that is redistributed as plough-layer interflow. This is controlled by differences in structure, which is in turn controlled by clay content. In fact, strong relationships between drainage parameters and soil clay content are shown to exist. Despite significant differences in redistribution pathways in different soils, three out of the four soil series studied show similar drainage efficiencies of approximately 50%. This has important implications for drainage design where crops are sensitive to prolonged high water content in the root zone. (Author's abstract)
W89-05119

HYDROLOGICAL RESPONSE OF A SILTY CLAY LOAM FOLLOWING DRAINAGE TREATMENT,
Seale-Hayne Coll., Newton Abbot (England). Dept. of Science.
R. J. Parkinson, S. J. Twomlow, and I. Reid.
Agricultural Water Management AWMADF, Vol. 14, No. 1-4, p 125-136, August 1988. 5 fig, 11 ref.

Descriptors: *Clay loam, *Silt, *Drainage, *Drainage effects, *Agricultural hydrology, *Soil absorption capacity, Clay, Soil density, Field tests, Loam, Soil water, England, Recharge, Soil properties, Experimental farms.

A drainage experiment has been designed to investigate the effect of soil loosening on the efficiency of water disposal in structurally unstable silt soils of the Sportsmans Association. Such soils are common on the Paleozoic slates of S.W. England. Six drains were laid with permeable fill at 20 m spacing on a sloping site at Seale-Hayne college Farm. Following installation, half of the site was loosened to a depth of 0.40 m. The dry bulk density of the loosened zone, measured six months after deep cultivation was significantly lower than the unloosened soil, typically 0.85 against 1.05 t/cu m. This is shown to have unexpected effects on water distribution. Selected drain outfall hydrographs from each plot show that antecedent soil produces lower peak discharges and lower short-term (24 h) drainage efficiencies when the soil has been fully recharged by previous rain; however the prolonged nature of drainage from the loosened soil leads eventually to greater efficiencies over a longer-term period of 48 h. When the system is not fully recharged prior to a storm, the 'temporary' storage capacity of the loosened soil delays drainage; peak discharge is again lower than in the unloosened soil, but drainage efficiencies remain lower even after 48 h. The soil and crop management implications are that the loosened soil is less dense but wetter. It is shown that this leads to lower shear strength and reduced bearing capacity, so that opportunities for machinery access or grazing are reduced, contrary to expectation. (Author's abstract)
W89-05120

DRAINAGE PROBLEMS IN MOUNTAINOUS AREAS,
Universitaet fuer Bodenkultur, Vienna (Austria). Inst. fuer Wasserwirtchaft.
For primary bibliographic entry see Field 4B.
W89-05123

DRAINAGE HYDROLOGY IN THE MARSHLANDS OF WESTERN FRANCE,
Centre National du Machinisme Agricole, du Genie Rural, des Eaux et des Forets, Cestas Principal (France). Div. Hydraulique Agricole.
For primary bibliographic entry see Field 4B.
W89-05124

EMPIRICAL APPROACH FOR PREDICTING RUNOFF YIELD UNDER DESERT CONDITIONS,
Ben-Gurion Univ. of the Negev, Sde Boker (Israel). Jacob Blaustein Inst. for Desert Research.
For primary bibliographic entry see Field 2E.
W89-05130

WATER HARVESTING STRATEGIES IN THE SEMIARID CLIMATE OF SOUTHEASTERN SPAIN,
Instituto Nacional de Investigaciones Agrarias, Cordoba (Spain).
J. V. Giraldez, J. L. Ayuso, A. Garcia, J. G. Lopez, and J. Roldan.
Agricultural Water Management AWMADF, Vol. 14, No. 1-4, p 253-263, August 1988. 10 fig, 12 ref.

Descriptors: *Water harvesting, *Irrigation canals, *Irrigation design, *Runoff, *Semiarid lands, *Hydrologic models, Irrigation practices, Dikes, Farming, Rainfall-runoff relationships, Spain.

The low annual rainfall in southeastern Spain does not allow conventional dryfarming. Therefore local farmers have developed runoff farming strategies since early times. Among the wide variety of techniques, one can distinguish three main types depending on the location in the basin: The 'canada' catches the runoff from the small, narrow valleys in the upstream part of the watershed; the 'boquera', an earth dike, diverts the flood waters occasionally appearing in upland dry washes, to small cultivated areas previously prepared in the bed border; the third one occurs near the basin

outlet, where a more elaborated stone-made diversion dike leads the waters to a conveyance canal, 'acequia de canon', for its successive distribution to the irrigated fields. A simple hydrological model contributes to the understanding of these water harvesting devices. (Author's abstract)
W89-05131

READJUSTING THE WATER BALANCE TO COMBAT DRYLAND SALTING IN SOUTHERN AUSTRALIA: CHANGING THE HYDROLOGY OF A TEXTURE CONTRAST SOIL BY DEEP RIPPING,
Land Protection Service, Bendigo (Australia).
For primary bibliographic entry see Field 3C.
W89-05134

IMPORTANCE OF HYDROLOGICAL RESEARCH IN DESIGNING RURAL WATER MANAGEMENT SYSTEMS AS PART OF LAND DEVELOPMENT PROJECTS IN THE NETHERLANDS,
Institute for Land and Water Management Research, Wageningen (Netherlands).
For primary bibliographic entry see Field 3F.
W89-05142

OPERATIONAL ASPECTS OF SURFACE WATER MANAGEMENT IN RELATION TO THE HYDROLOGY OF AGRICULTURAL AREAS AND NATURE RESERVES,
Institute for Land and Water Management Research, Wageningen (Netherlands).
For primary bibliographic entry see Field 3F.
W89-05143

HYDROLOGICAL RESEARCH AND THE DESIGN OF A WATER MANAGEMENT SYSTEM FOR A PEATLAND AREA WITH AGRICULTURE AND NATURE IN THE LAND CONSOLIDATION PROJECT: ECHTENER AND GROOTE VEENPOLDER,
Institute for Land and Water Management Research, Wageningen (Netherlands).
For primary bibliographic entry see Field 3F.
W89-05144

HYDROCHEMISTRY OF RICH FEN AND WATER MANAGEMENT,
Institute for Land and Water Management Research, Wageningen (Netherlands).
For primary bibliographic entry see Field 2H.
W89-05145

IMPACT OF WATER MANAGEMENT UPON GROUNDWATER FLUCTUATIONS IN A DISTURBED BOG RELICT,
Agricultural Univ., Wageningen (Netherlands). Dept. of Land and Water Use.
J. M. Schouwenaars.
Agricultural Water Management AWMADF, Vol. 14, No. 1-4, p 439-449, August 1988. 4 fig, 2 tab, 15 ref.

Descriptors: *Groundwater level, *Water level fluctuations, *Water management, *Groundwater management, *Bogs, *Peat bogs, Hydrologic models, Soil water table, The Netherlands.

In many disturbed bog relicts in northwestern Europe, attempts have been made to restore the hydrological conditions required for the re-establishment of ombrotropic plant communities. Water management measures were taken to reduce water losses and to raise groundwater levels in the bog relicts. Experiences show that after having taken these measures, on many sites groundwater levels remain low at the end of the summer. Suitable conditions for the regeneration of a Shpagnum vegetation mostly are restricted to permanently inundated sites. The study presented here aims to clarify the importance of different hydrological characteristics such as hydro-physical properties of the peat layer, transpiration, downward water losses, etc. for the water fluctuations in bog relicts. A groundwater simulation model for peaty soils was developed (SWAMP, Soil WAter Modeling in Peat), which makes it possible to evaluate alternative water management measures. In this study the model was used for a location in the Deurnese Peel area in the Netherlands. The results of this study demonstrate the importance of the hydro-physical characteristics of the peat layers for the pattern of groundwater fluctuations. More than any other hydrological variable it seems to be the pore size distribution within the upper peat layers that determines groundwater fluctuations. Probably in most disturbed bog relicts, the hydro-physical properties of the upper layers are not suited for the establishment of a Shpagnum vegetation directly on the substrate. Only on permanently inundated sites can floating mats of Shpagnum peat develop. On these sites the required hydro-physical conditions within the young upper peat layers are gradually created. (Author's abstract)
W89-05148

INTEGRATION OF WETLANDS INTO MAN-MADE LANDSCAPES OF N.W. GERMANY,
Niedersaechsisches Landesamt fuer Bodenforschung, Bremen (Germany, F.R.). Bodentechnologisches Inst.
For primary bibliographic entry see Field 2H.
W89-05149

RESTORATION OF THE VECHT LAKES ECOSYSTEMS SURROUNDING THE HORSTERMEER POLDER: A FEASIBILITY STUDY,
Witteveen and Bos, Deventer (Netherlands).
P. H. Schouten, P. J. T. Verstraelen, and J. J. Buntsma.
Agricultural Water Management AWMADF, Vol. 14, No. 1-4, p 471-479, August 1988. 3 fig, 1 tab, 12 ref.

Descriptors: *Lakes, *The Netherlands, *Lake restoration, *Water management, Polders, Saline water, Seepage, Computer models, Project planning, Flushing, Feasibility studies.

The Vecht lakes area, 20 km south-east of Amsterdam, is known for its rich variety of flora and fauna as well as for its characteristic landscape. However, the value of this area is steadily diminishing, mainly due to the necessity of supplementary water from the polluted Vecht river. In the past several alternatives aiming at the restoration of the Vecht lakes ecosystems have been investigated. The most promising alternative is the use of the surplus of upward fresh seepage water from the Horstermeer Polder. A complicating factor is the seepage water in the center of the Horstermeer Polder, which is unsuitable for water supply because of its high chloride content (up to 4000 mg Cl/L). A water management plan for the Horstermeer Polder has been prepared, based on the results of computer simulations of the flow of the water in the ditch system. The plan consists of a sub-division of the polder in three ares, the construction of two pumping stations and several sliding weirs. The impact of the plan on the agricultural conditions in the Horstermeer Polder is as follows: The water level in the ditches will change and the Cl content of surface water will increase so that sprinkling irrigation of horticultural crops will become impossible, however cattle watering would still be possible in main ditches. Because of the increasing chloride content in the center area of the polder during the dry season, the plan has been extended with flushing facilities. The center area will be flushed with water from the Lake IJssel. (Vernooy-PTT)
W89-05151

REUSE AND DISPOSAL OF HIGHER SALINITY SUBSURFACE DRAINAGE WATER: A REVIEW,
California Regional Water Quality Control Board, Sacramento.
For primary bibliographic entry see Field 3C.
W89-05152

TIDAL SALT MARSH RESTORATION,
North Carolina State Univ. at Raleigh. Dept. of Soil Science.
For primary bibliographic entry see Field 5G.
W89-05255

CONSUMPTIVE USE OF STREAMFLOW INCREASES IN THE COLORADO RIVER BASIN,
Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.
For primary bibliographic entry see Field 6D.
W89-05270

CHANNEL WIDENING CHARACTERISTICS AND BANK SLOPE DEVELOPMENT ALONG A REACH OF CANE CREEK, WEST TENNESSEE,
For primary bibliographic entry see Field 2J.
W89-05596

REGIONAL FLOOD FREQUENCY ANALYSIS: PROCEEDINGS OF THE INTERNATIONAL SYMPOSIUM ON FLOOD FREQUENCY AND RISK ANALYSES, 14-17 MAY 1986, LOUISIANA STATE UNIVERSITY, BATON ROUGE, U.S.A.
For primary bibliographic entry see Field 2E.
W89-05614

4B. Groundwater Management

ORDINANCE FOR THE CONTROL OF URBAN DEVELOPMENT IN SINKHOLE AREAS IN THE BLUE GRASS KARST REGION, LEXINGTON, KENTUCKY,
Kentucky Geological Survey, Lexington.
J. S. Dinger, and J. R. Rebmann.
IN: Proceedings of the Environmental Problems in Karst Terranes and Their Solutions Conference. National Water Well Association, Dublin, OH. 1986. p 163-180, 7 ref, 1 append.

Descriptors: *Karst hydrology, *Kentucky, *Urban planning, *Legal aspects, Hydraulics, Ordinances, Sinkholes, Storm runoff.

It has become increasingly apparent that the Lexington-Fayette Urban-County Government, developers, and builders responsible for development in sinkhole areas may be liable for damages if it can be shown that development took place in an area where sinkhole problems could be expected to occur. For this reason, a sinkhole ordinance was created and adopted in 1985 by the Lexington-Fayette Urban-County Government. This ordinance defines sinkhole-drainage areas, development-plan requirements, non-buildable areas, and required hydrogeologic studies that must be submitted for governmental review in order to request approval for urban development. The ordinance prohibits the filling of sinkholes and limits development within their boundaries as well as the discharge of storm water into sinkholes. Sinkhole boundaries are defined on topographic maps with 5-foot contours. The designated boundaries of sinkholes may be reduced if the developer submits a hydrologic study of the sinkhole system that indicates the proposed urban development will not have an adverse effect. Non-developable areas may be set aside for open space, parks, or green belts. An increase in development density is allowed to offset the cost of land that is determined to be non-developable. (See also W89-04586) (Author's abstract)
W89-04594

GROUND WATER MONITORING CONSIDERATIONS IN KARST ON YOUNG LIMESTONES,
Florida Sinkhole Research Inst., Orlando.
For primary bibliographic entry see Field 5B.
W89-04597

LOW SLUMP COMPACTION GROUTING FOR CORRECTION OF CENTRAL FLORIDA SINKHOLES,
GKN Hayward Baker, Inc., Tampa, FL.
J. F. Henry.
IN: Proceedings of the Environmental Problems in Karst Terranes and Their Solutions Conference.

National Water Well Association, Dublin, OH. 1986. p 368-377, 8 fig, 3 ref.

Descriptors: *Sinkholes, *Florida, *Karst, *Compaction, *Grouting, Civil engineering, Engineering, Rock mechanics.

By adapting available technology and using it as an innovative approach to solving Florida's sinkhole problems, compaction grouting has been demonstrated to be a cost-effective and efficient solution because of its capacity to: (1) fill and plug large rock cavities with a minimum of material; (2) redensify granular overburden soils that have been disturbed and loosened by sinkhole activity; and (3) lift damaged structures. The development of a complete program is vital. This should include a thorough site investigation by a qualified geotechnical engineer, compaction grouting and comprehensive monitoring by an experienced specialty contractor and post-construction testing to verify results. Case studies involving two residences in Tampa, one a townhouse and the other a single family dwelling, are presented. (See also W89-04586) (Hammond-PTT)
W89-04604

EVALUATION OF THE WATER-SUPPLY POTENTIAL OF AQUIFERS IN THE POTOMAC GROUP OF ANNE ARUNDEL COUNTY, MARYLAND,
Maryland Geological Survey, Baltimore.
F. K. Mack, and G. Achmad.
Maryland Geological Survey Report of Investigations No. 46, 1986. 111p, 66 fig, 11 tab, 37 ref.

Descriptors: *Pumpage, *Water resources data, *Geohydrology, *Water supply, *Groundwater budget, *Aquifers, *Maryland, Water resources, Model studies, Groundwater depletion, Patapsco River, Magothy Aquifer, Hydrologic models, Observation wells.

A multi-layer aquifer model was developed to simulate the effects of pumping stresses on aquifers in the Potomac Group in northern Anne Arundel County, Maryland. The model represents a hydrologic system including four Coastal Plain aquifers known locally as the Patuxent, the lower Patapsco, the upper Patapsco, and the overlying Magothy aquifer. These aquifers are layers composed mainly of sands that dip gently to the southeast from band-shaped outcrops in the northwestern part of the modeled area, and are separated from one another in downdip areas by relatively impermeable confining beds. The model was developed by using measured values for the hydrologic properties of the aquifers and confining beds where they were available and by using estimated values where measured values were not available. The model was calibrated by using monthly pumpage of more than 250 production wells and water levels measured in 39 observation wells over the 12-year period from December 1965 through December 1977. The calibration was accomplished by comparing the computed potentiometric levels with the corresponding water levels measured in the field for both steady-state and transient-state conditions. The maximum difference between the computed and observed water levels of the 39 observation wells was about 30 feet, but the difference was generally less than 10 feet. Trends of 30 of 39 hydrographs compared well; eight were fair, and one was poor. Pumpage by the Anne Arundel County Department of Utilities, other governmental agencies, and industry is expected to total 118 million gallons per day by the year 2000 in the model area, which includes all of Anne Arundel County and portions of the adjacent counties. The calibrated model was used to predict the effect of that pumpage on water levels in each aquifer. The results indicated that deep cones of depression would be developed in some aquifers, but that the well fields could provide the quantities needed. (Author's abstract)
W89-04629

APPLICATION OF A NUMERICAL GROUNDWATER FLOW MODEL TO THE MUD LAKE AREA IN SOUTHEASTERN IDAHO,
Idaho Water and Energy Resources Research Inst., Moscow.
For primary bibliographic entry see Field 2F.
W89-04644

PROJECTED EFFECTS OF PROPOSED INCREASED PUMPAGE ON WATER LEVELS AND SALINITY IN THE SPARTA AQUIFER NEAR WEST MONROE, LOUISIANA,
Geological Survey, Baton Rouge, LA. Water Resources Div.
D. A. Trudeau, and A. Buono.
Water Resources Technical Report No. 39, 1985. 70p, 9 fig, 8 tab, 9 plates, 31 ref, 2 append.

Descriptors: *Water resources development, *Ecological effects, *Model studies, *Groundwater level, *Sparta aquifer, *Pumpage, *Groundwater management, Louisiana, Water supply, Salinity, Simulation analysis, Saline water intrusion, Pumping, Groundwater recharge, Leakage.

A groundwater model of the Sparta aquifer was developed to evaluate the effects on water levels and salinity of proposed increased pumping to meet projected water supply requirements for the Monroe-West Monroe, LA area. A detailed three-dimensional model of the aquifer and overlying and underlying confining layers and aquifers was prepared and calibrated for the period 1900-1964, using parameter-estimation techniques and the observed change in water levels in wells in the Sparta aquifer. The model indicates that 45% of the total water pumped from the Sparta aquifer between 1900 and 1980 was derived from leakage through confining layers, 38% from recharge in the outcrop-subcrop area, 17% was released from storage in the aquifer. Eight alternate pumping plans proposed by the Corps of Engineers for the period 1980-2040 were evaluated using the developed model. These plans projected additional pumpage from the Sparta aquifer ranging from 10 to 226 cu ft/sec. Water level declines simulated by the model indicate that water levels in wells in the Sparta aquifer will eventually drop below the top of the aquifer near West Monroe with all plans. The maximum projected water level decline for the various plans ranges from 51 to 296 ft. Evaluation of the effects of the various pumping plans on the rate of movement of downdip saltwater towards West Monroe indicates that the rate would increase 34 to 74% from the 1980 projected rate of about 30 to 100 ft/yr; however, this would not result in a significant change in water quality at West Monroe for at least 200 years. Pumping plan A, which calls for an increase in pumpage of 10.58 cu ft/sec through 2040, would minimize the areal extent of excessive drawdown. In addition, it would produce the slowest rate of water movement from the saltwater front towards West Monroe. (Author's abstract)
W89-04661

HYDROLOGICAL RESEARCH IN DISTURBED BOGS AND ITS ROLE IN DECISIONS ON WATER MANAGEMENT IN THE NETHERLANDS,
Agricultural Univ., Wageningen (Netherlands). Dept. of Land and Water Use.
For primary bibliographic entry see Field 2H.
W89-04713

GROUNDWATER SYSTEMS PLANNING AND MANAGEMENT,
Humboldt State Univ., Arcata, CA. Dept. of Environmental Resources Engineering.
R. Willis, and W. W.-G. Yeh.
Prentice-Hall, Inc., Englewood Cliffs, NJ. 1987. 416 p.

Descriptors: *Groundwater management, *Hydrologic models, *Groundwater budget, Simulation analysis, Mathematical models, Artificial recharge, Pumping, Water use, Competing use, Mathematical equations.

The management of groundwater resources involves the allocation of groundwater supplies and water quality to competing water demands and uses. The resource allocation problem is characterized by conflicting objectives and complex hydrologic, environmental, and economic constraints. Although simulation models provide the resource planner with important tools for managing the groundwater system, the predictive models do not identify the optimal groundwater development, design, or operational policies for an aquifer system. Instead, the simulation models provide only localized information regarding the response of the groundwater system to pumping and/or artificial recharge. Groundwater optimization models are predicated on numerical models of the aquifer system. The imbedding, response, or transfer equation approach is emphasized in the development of the management models for groundwater planning. Because these techniques, and the underlying equations describing flow and mass transport in confined and unconfined aquifer systems, are pivotal in the development of the management models, Chapters 2, 3, and 4 summarize the governing equations of the groundwater system and survey current numerical methods. Chapter 5 presents some of the more common optimization methods and algorithms that have been used for the solution of groundwater management models. The problems associated with the regional management of groundwater supplies are presented in Chapter 6, discussing general groundwater problems, optimal groundwater development and operation, the capacity expansion problem, and the conjunctive management of groundwater and surface water supplies. Numerous example problems demonstrate the application of optimization modeling for the solution of these problems. Groundwater quality management is discussed in Chapter 7. In Chapter 8, parameter identification methods are classified under the error criterion used in the formulation of the inverse problem. (Lantz-PTT)
W89-04830

EDWARDS AQUIFER. EXTREMELY PRODUCTIVE, BUT.... A SOLE-SOURCE WATER SUPPLY FOR SAN ANTONIO AND SURROUNDING COUNTIES IN SOUTH-CENTRAL TEXAS,
Geological Survey, San Antonio, TX.
For primary bibliographic entry see Field 2F.
W89-04831

GROUND-WATER FLOW BENEATH LEVEE 35A FROM CONSERVATION AREA 2B, BROWARD COUNTY, FLORIDA,
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-04906

HISTORY OF GROUND-WATER PUMPAGE AND WATER-LEVEL DECLINE IN THE BLACK CREEK AND UPPER CAPE FEAR AQUIFERS OF THE CENTRAL COASTAL PLAIN OF NORTH CAROLINA,
Geological Survey, Raleigh, NC. Water Resources Div.
M. D. Winner, and W. L. Lyke.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4168. 1986. 21p, 8 fig, 1 tab, 14 ref, 1 plate in pocket.

Descriptors: *Groundwater level, *Pumpage, *Water use, *History, *North Carolina, Municipal water, Industrial water, Aquifers, Urban areas, Rural areas, Groundwater recession.

Historical ground-water withdrawals and a general water-level decline in the Black Creek and upper Cape Fear aquifers of the central Coastal Plain of North Carolina are documented. Total municipal and industrial pumpage from these aquifers has increased from approximately 120,000 gal/day (gpd) in 1910 to > 21 million gpd in 1980. Major pumpage, > 10,000 gpd, began around 1900. Since that time, per capita water use in the central Coastal Plain area has ranged from 17 to 172 gpd/person. The higher values partially represent the increasing availability and use of modern conveniences since the World War II era. The range of per capita water use can be subdivided according

to general water-use and population characteristics for both urban and rural areas. The pumpage of ground water from the Black Creek and upper Cape Fear aquifers has created water-level declines from 0.5 to 4.9 ft/year since 1900. Approximately a third of the study area has experienced a decline > 50 ft up to the period 1979-1981, with 148 ft being the maximum. (Author's abstract)
W89-04939

CHARACTERISTICS AND PROPERTIES OF THE BASIN-FILL AQUIFER DETERMINED FROM THREE TEST WELLS WEST OF ALBUQUERQUE, BERNALILLO COUNTY, NEW MEXICO,
Geological Survey, Albuquerque, NM. Water Resources Div.
D. W. Wilkins.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4187, 1987. 78p, 3 plates, 25 fig, 12 tab, 22 ref.

Descriptors: *Geohydrology, *Aquifer characteristics, *Groundwater, *Transmissivity, *Aquifers, *New Mexico, Drilling, Iron, Manganese, Vertical flow, Water quality.

Three test wells were drilled west of Albuquerque; two are on the mesa west of the city, the third well is near the Rio Grande flood plain, west of the river. Test well 1, was drilled to a depth of 1,204 ft. Transmissivity of perforated intervals in the alluvial zone (980-1121 ft) ranged from 3.1 to 3.9 ft sq/day, and horizontal hydraulic conductivity from .02 to .03 ft/day. Vertical hydraulic conductivity of the semiconfining layer between the alluvial and volcanic zones is estimated to range from .00031 to .0031 ft/day. Transmissivity of the volcanic zone (1139-1179 ft) is about 81 ft sq/day, and horizontal hydraulic conductivity is about 2.0 ft/day. Dissolved-iron and manganese concentrations exceed recommended constituent limits for a public water supply. Vertical flow is upward; the potentiometric surface in the volcanic zone is about 2 ft higher than in the alluvial zone. Water levels are about 883 ft below land surface. Test well 2 was drilled to a depth of 1,828 ft below land surface with seven intervals open to the aquifer. During development, fine sand and silt entered the casing, filling it to a depth of 1,500 ft. The dissolved-cadmium concentration exceeds the maximum contaminant level and the dissolved-manganese concentration exceeds the recommended constituent limit for a public water supply. The vertical flow gradient is downward; the potentiometric surface in the middle and lower zones is about 17 ft lower than in the upper zones. Depth to water in the upper zone is about 767 below land surface and in the lower two zones the depth to water is about 784 ft below land surface. Test well 3 was drilled to a depth of 1,050 ft. Only the interval from 490 to 590 ft below land surface could be used to calculate transmissivity which was about 1,300 ft sq/day; horizontal hydraulic conductivity is about 13 ft/day. Quality of water is acceptable for a public water supply. Vertical flow is downward; the potentiometric surface in the deepest interval is about 7 ft lower than that in the uppermost zone. In the shallow interval from 350 to 590 ft below land surface, depth to water is about 24 ft below land surface. In the interval from 710 to 790 ft below land surface, depth to water is about 29 ft below land surface and in the interval from 870 to 1,050 ft below land surface, depth to water is 31 ft below land surface. (Author's abstract)
W89-04952

ACID SULFATE SOILS OF THE MANGROVE SWAMPS OF RIVERS STATE, NIGERIA,
Rivers State Univ. of Science and Technology, Port Harcourt (Nigeria). Faculty of Agriculture.
For primary bibliographic entry see Field 3F.
W89-05007

DRAINAGE BENEFITS: WATERTABLE CONTROL, WORKABILITY AND CROP YIELDS,
Ministry of Agriculture, Fisheries and Food, Cambridge (England). Field Drainage Experimental Unit.
For primary bibliographic entry see Field 4A.
W89-05111

WATERTABLE CONTROL INDICES FOR DRAINAGE OF AGRICULTURAL LAND IN HUMID CLIMATES,
Euroconsult, Arnhem (Netherlands).
For primary bibliographic entry see Field 4A.
W89-05114

WATER MANAGEMENT AND DRAINAGE DESIGN OF A SELECTED POLDER,
Gdansk Technical Univ. (Poland). Inst. of Hyrdotechnics.
For primary bibliographic entry see Field 4A.
W89-05118

HYDROLOGICAL RESPONSE OF A SILTY CLAY LOAM FOLLOWING DRAINAGE TREATMENT,
Seale-Hayne Coll., Newton Abbot (England). Dept. of Science.
For primary bibliographic entry see Field 4A.
W89-05120

PREFERENTIAL FLOW INFLUENCES ON DRAINAGE OF SHALLOW SLOPING SOILS,
New York State Coll. of Agriculture and Life Sciences, Ithaca. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 2G.
W89-05121

DRAINAGE PROBLEMS IN MOUNTAINOUS AREAS,
Universitaet fuer Bodenkultur, Vienna (Austria). Inst. fuer Wasserwirtchaft.
F. Kastanek.
Agricultural Water Management AWMADF, Vol. 14, No. 1-4, p 169-174, August 1988. 5 fig, 11 ref.

Descriptors: *Drainage, *Drainage engineering, *Mountains, *Alpine regions, *Hydrology, Soil water table, Groundwater level, Groundwater movement, Hydraulic conductivity.

Drainage problems in mountainous areas can be caused by shallow groundwater levels due to high precipitation rates, or by several other factors such as soil properties, especially a low hydraulic conductivity, and the field conditions with respect to the outlet of drainage water into a river. Drainage in alpine valleys is often complicated by groundwater originating from the river, and from the hillsides of the mountain. Depending on its origin the drainage problem needs different methods to be solved. These include parallel drain systems and interceptor drains. The use of mole drainage to alleviate waterlogging caused by low hydraulic conductivity of the topsoil is also discussed. (Vernooy-PTT)
W89-05123

DRAINAGE HYDROLOGY IN THE MARSHLANDS OF WESTERN FRANCE,
Centre National du Machinisme Agricole, du Genie Rural, des Eaux et des Forets, Cestas Principal (France). Div. Hydraulique Agricole.
B. Bremond, J. M. Caupenne, and P. Collas.
Agricultural Water Management AWMADF, Vol. 14, No. 1-4, p 175-183, August 1988. 6 fig, 2 tab, 11 ref.

Descriptors: *Land reclamation, *Drainage engineering, *Drainage hydrology, *Wetlands, *Drainage, *Marshes, *France, *Agricultural hydrology, Model studies, Model testing, Controlled drainage, Hydrologic models, Hydrology, Groundwater level, Pumping, Unit hydrographs, Effective precipitation.

Flux prediction for drained fields can be obtained from convolution of a unit hydrograph with effective rain. The latter is calculated using a reservoir model, whose only parameter is the reduction coefficient of PET applied to gross rainfall. The transfer coefficient is calculated by two convolution methods, projection and multiple linear regression under constraints. The model is applied to data obtained from drained plots in the marshlands of Western France, which are flat and lying at sea level. Since in wet winter periods natural drainage is insufficient for crop production, some farmers lower the water level by pumping. In 5 plots ranging from 18 to 48 hectares, the evacuated flow was measured at the pump together with rainfall and PET. Results are used to fit the reservoir parameter of the model. Although the model is purely stochastic, the results obtained can be interpreted in terms of the permeability of the plot and the type of drainage. (Author's abstract)
W89-05124

IRRIGATION, GROUNDWATER ABSTRACTION AND STREAM FLOW DEPLETION,
Danish Land Development Service, Viborg. Research Dept.
For primary bibliographic entry see Field 3F.
W89-05140

INFLUENCE OF WATER LEVEL MANAGEMENT AND GROUNDWATER QUALITY ON VEGETATION DEVELOPMENT IN A SMALL NATURE RESERVE IN THE SOUTHERN GELDERSE VALLEI (THE NETHERLANDS),
Agricultural Univ., Wageningen (Netherlands). Dept. of Land and Water Use.
For primary bibliographic entry see Field 4C.
W89-05147

TONGALA GROUNDWATER PUMPING/RE-USE PROJECT: A PILOT STUDY FOR GROUNDWATER TABLE CONTROL IN THE SHEPPARTON REGION IN NORTHERN VICTORIA,
Victoria Dept. of Agriculture and Rural Affairs, Tatura (Australia). Inst. for Irrigation and Salinty.
A. F. Heuperman.
Agricultural Water Management AWMADF, Vol. 14, No. 1-4, p 513-523, August 1988. 4 fig, 4 tab, 8 ref.

Descriptors: *Groundwater irrigation, *Water table, *Water table rise, *Saline soil, *Saline water, *Australia, Groundwater levels, Field tests, Soil water table, Farm management.

Rising saline watertables and associated increasing soil salinity problems are threatening agricultural production in Northern Victoria. The Tongala project is a pilot scheme to investigate the strategy to integrate groundwater pumping for salinity control with on-farm use of the water. The project was initiated in May 1980 and became operational in 1981. Eleven major dairy farms (> 20 ha), one orchard and 8 smaller properties are included in the project area which covers 610 ha. Seventeen groundwater pumps are now operational. The project monitors watertable level, piezometric levels, soil salinities, watertable salinities, rainfall, evaporation, pumped volumes, pumped water qualities and irrigation water use. After 5 years of operation the project farmers pumped enough groundwater to keep watertables at > 1 m below the surface. The groundwater pumping/re-use management system offers only a temporary solution to the problem of increasing salinity. In the long term, aquifer salinization is likely to occur as salts are both washed down from the overburden into the aquifer and laterally drawn in from surrounding areas. Salt balance, both on a regional and on a farm scale, is a prerequisite for a long term sustainable agricultural system. (Vernooy-PTT)
W89-05153

FORECASTING THE SUITABILITY OF PUMPED GROUNDWATER FOR IRRIGATION IN THE NILE VALLEY,
Iwaco B.V., Rotterdam (Netherlands).
For primary bibliographic entry see Field 3F.
W89-05154

WATER TABLE CONTROL, REUSE AND DISPOSAL OF DRAINAGE WATER IN HARYANA,
Euroconsult, Arnhem (Netherlands).
For primary bibliographic entry see Field 3F.
W89-05155

SATURATED SOIL HYDRAULIC CONDUCTIVITY IN LOBLOLLY PINE PLANTATIONS ON DRAINED SITES,
Raleigh, NC.
For primary bibliographic entry see Field 2F.
W89-05264

DEVELOPING A STATE WATER PLAN: GROUND-WATER CONDITIONS IN UTAH, SPRING OF 1984,
Geological Survey, Salt Lake City, UT. Water Resources Div.
C. Avery.
Utah Department of Natural Resources Cooperative Investigations Report Number 24, 1984. 79p, 40 fig, 3 tab, 2 ref.

Descriptors: *Groundwater management, *Utah, *Water resources data, *Hydrologic data collections, Water use, Wells, Water supply, Groundwater mining, Groundwater quality, Groundwater irrigation, Municipal water, Industrial water, Precipitation.

The twenty-first in a series of annual reports describes groundwater conditions in Utah, and contains information on well construction, groundwater withdrawals from wells, water-level changes, and related changes in precipitation and streamflow. The estimated total withdrawal of water from wells in Utah during 1983 was about 607,000 acre-ft, which is about 183,000 acre-ft less than during 1982 and about 215,000 acre-ft less than the average annual withdrawal for 1973-82. The decrease in withdrawal primarily was due to a decrease in withdrawal for irrigation and public supply. Total withdrawal for irrigation during 1983 was about 334,000 acre-ft, which is 170,000 acre-ft less than reported for 1982. Withdrawal for public supply was 130,000 acre-ft, which is 14,000 acre-ft less than during 1982. Withdrawal for industry was 80,000 acre-ft, which is slightly less than reported for 1982. Withdrawals for domestic and stock use was 63,000 acre-ft, which is 5,000 acre-ft greater than during 1982. The quantity of water withdrawn from wells is related to local climatic conditions. Precipitation during 1983 was above average throughout Utah. Of the 33 weather stations for which graphs of cumulative departure from average annual precipitation are included, seven stations recorded about twice the average annual amount. (Lantz-PTT)
W89-05402

DEVELOPING A STATE WATER PLAN: GROUND-WATER CONDITIONS IN UTAH, SPRING OF 1983,
Geological Survey, Salt Lake City, UT. Water Resources Div.
C. L. Appel.
Utah Department of Natural Resources Cooperative Investigations Report Number 23, 1983. 97p, 58 fig, 3 tab, 3 ref.

Descriptors: *Groundwater level, *Water resources data, *Hydrologic data collections, *Groundwater management, *Utah, Groundwater mining, Groundwater quality, Groundwater irrigation, Municipal water, Industrial water, Precipitation, Water supply, Streamflow, Groundwater recharge, Groundwater reservoirs.

The twentieth in a series of annual reports describes groundwater conditions in Utah, and contains information on well construction, groundwater withdrawals, water level changes, and related changes in precipitation and streamflow. The estimated total withdrawal of water from wells in Utah in 1982 was about 794,00 acre-ft, which is about 49,000 acre-ft less than in 1981, and 32,000 acre-ft less than the 1972-81 average annual withdrawal. The decrease in withdrawal primarily was due to a decrease in withdrawal for irrigation. The quantity of water withdrawn from wells is related to local climatic conditions. Precipitation in 1982 was above average in almost all of Utah. Of the 33 stations for which graphs of cumulative departure from average annual precipitation are included, only 2 had below average precipitation in 1982. A result of the above average precipitation was above average surface water supplies and therefore less water was withdrawn for irrigation. The above average precipitation in most of the State in 1982 resulted in increased recharge to the groundwater reservoirs. This, coupled with decreased withdrawals, resulted in rises in groundwater levels in most of the State from spring of 1982 to spring of 1983. Continued large withdrawals for irrigation, however, resulted in general declines of groundwater levels in the Milford and Beryl-Enterprise areas of Escalante Valley. (Lantz-PTT)
W89-05403

GROUND-WATER CONDITIONS IN SALT LAKE VALLEY, UTAH, 1969-83, AND PREDICTED EFFECTS OF INCREASED WITHDRAWALS FROM WELLS,
Geological Survey, Salt Lake City, UT. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-05412

DEVELOPMENT OF GROUND-WATER RESOURCES IN ORANGE COUNTY, TEXAS, AND ADJACENT AREAS, 1971-80,
Geological Survey, Austin, TX. Water Resources Div.
C. W. Bonnet, and R. K. Gabrysch.
Texas Department of Water Resources Report 283, October 1983. 49p, 11 fig, 5 tab, 18 ref.

Descriptors: *Groundwater management, *Orange County, *Texas, Chicot aquifer, Groundwater mining, Municipal water, Industrial water, Evangeline aquifer, Groundwater level, Groundwater budget, Saline water intrusion, Subsidence, Groundwater quality.

Pumpage in Orange County from the lower unit of the Chicot aquifer averaged 21.2 million gallons per day (gpd) and pumpage from the upper unit of the Chicot averaged about 2 million gpd from 1971-79. Annual pumpage increased in municipal areas and decreased in industrial areas with little net change in total annual pumpage during the report period. The major water-bearing unit in the study area is the Chicot aquifer, which overlies the Evangeline aquifer. The Evangeline aquifer is undeveloped in Orange County, but is developed at Evadale in Jasper County, Texas, and at Silsbee in Hardin County, Texas. Both aquifers consist of unconsolidated and discontinuous layers of sand and clay that gently dip toward the Gulf of Mexico. Water levels in Orange County tended to stabilize or rise in areas where groundwater withdrawals decreased. Elsewhere in Orange County, most water levels continued to decline, generally at a slower rate than before 1971. Bench-mark elevations determined during 1973 show regional land-surface subsidence from 1918-73, generally attributed to groundwater development, to be less than 0.5 ft. Locally, subsidence due to production of oil, gas, saltwater, or sulfur was about 15 ft at Spindletop Dome, Jefferson County, Texas, and as much as 3 ft near Port Acres gas field, Jefferson County, Texas. Although saltwater encroachment is evident in parts of southern Orange County, the encroachment is not expected to be detrimental if the groundwater pumping remains stable and the projected increase in demands for water is met with surface water supplies. (Author's abstract)
W89-05418

RECHARGE STUDIES IN THE WESTERN MURRAY BASIN: 2. RESULTS OF A DRILLING PROGRAM AT WAMBI,
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
For primary bibliographic entry see Field 2F.
W89-05423

VARIABLE DENSITY FLUID FLOW IN THE BRACKISH TRANSITION ZONE BETWEEN FRESH AND SALINE GROUNDWATER,
Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands).
For primary bibliographic entry see Field 2F.
W89-05470

PLANNING FOR GROUNDWATER PROTECTION.
For primary bibliographic entry see Field 5G.
W89-05600

RECHARGE STUDIES IN THE WESTERN MURRAY BASIN: 1. RESULTS OF A DRILLING PROGRAM AT BORRIKA,
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Soils.
For primary bibliographic entry see Field 2F.
W89-05757

DIGITAL SIMULATION OF GROUND-WATER FLOW IN THE HIGH PLAINS AQUIFER IN PARTS OF COLORADO, KANSAS, NEBRASKA, NEW MEXICO, OKLAHOMA, SOUTH DAKOTA, TEXAS, AND WYOMING,
Geological Survey, Lakewood, CO. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-05774

ASSESSMENT OF RURAL GROUNDWATER CONTAMINATION BY AGRICULTURAL CHEMICALS IN SENSITIVE AREAS OF MICHIGAN,
Michigan State Univ., East Lansing. Inst. of Water Research.
For primary bibliographic entry see Field 7C.
W89-05784

WATER RESOURCES OF FREDERICK COUNTY, MARYLAND,
Maryland Geological Survey, Baltimore.
For primary bibliographic entry see Field 2F.
W89-05785

SUBSURFACE GEOLOGY OF THE ST. CROIX CARBONATE SYSTEM, PHASE II,
College of the Virgin Islands, St. Thomas.
For primary bibliographic entry see Field 2F.
W89-05787

MODELING TRANSIENT GROUND WATER FLOW IN MULTILAYERED AQUIFER SYSTEMS,
Georgia Inst. of Tech., Atlanta. School of Civil Engineering.
For primary bibliographic entry see Field 2F.
W89-05790

4C. Effects On Water Of Man's Non-Water Activities

WATER MOVEMENT AND STORAGE IN THE UNSATURATED ZONE OF A MATURELY KARSTIFIED CARBONATE AQUIFER, MENDIP HILLS, ENGLAND,
Bristol Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 2F.
W89-04590

SINKHOLE INVESTIGATION: SOUTH-CENTRAL PENNSYLVANIA,
Buchart-Horn, Inc., York, PA.
For primary bibliographic entry see Field 2F.
W89-04602

HYDROGEOLOGIC IMPACT ASSESSMENT OF PROPOSED URBANIZATION ATOP A KARST AQUIFER,

NUS Corp., Houston, TX.
M. R. Schuknecht, and J. K. Mikels.
IN: Proceedings of the Environmental Problems in Karst Terranes and Their Solutions Conference. National Water Well Association, Dublin, OH. 1986. p 435-451, 4 fig, 18 ref.

Descriptors: *Edwards Aquifer, *Urban hydrology, *Geohydrology, *Urban planning, *Karst, *Environmental Impact statement, *Texas, Recharge, Runoff, Aquifers, Groundwater hydrology, Water quality, Water quantity, Planning, Drinking water, Irrigation water.

A systematic approach is outlined for assessing the potential impact of proposed urban development on a karst aquifer. To ensure environmentally sound planning and development strategies, site-specific hydrogeologic investigations must be conducted. Factors influencing surface recharge and runoff must be analyzed. These include stratigraphic, structural, and lithologic controls; drainage; and the development of soil profiles. Identification of karst features such as sinkholes, potholes, caves and solutionally enlarged faults and joints is crucial to site assessment. Two case studies at the Lakeline and Rivery properties on the northern segment of the Edwards aquifer will be emphasized to illustrate the assessment process. The Edwards aquifer is a sole source of drinking and irrigation water for groundwater quality and quantity deteriorations a result of development on its recharge zone. As a consequence, the Texas Water Commission and city and county governments have enacted ordinances to protect the Edwards aquifer recharge zone. Regional hydrogeologic studies are valuable tools in characterizing local groundwater systems. These field studies are used to describe and understand the recharge process, allowing regulators, planners and developers to understand the potential adverse effects of development on the recharge process and subsequent impact on the aquifer. (See also W89-04586) (Author's abstract)
W89-04609

PART II: SINKHOLES AND MAN,
Florida Sinkhole Research Inst., Orlando.
For primary bibliographic entry see Field 2F.
W89-04622

EFFECTS OF LAND USE ON DISCHARGE AND WATER QUALITY IN NEWAUKUM CREEK BASIN, KING COUNTY, WASHINGTON,
Geological Survey, Tacoma, WA. Water Resources Div.
E. A. Prych, and R. N. Brenner.
Municipality of Metropolitan Seattle, WA, August 1983. 62p, 12 fig, 20 tab, 11 ref.

Descriptors: *Urban runoff, *Land use, *Water quality, *Newaukum Creek, *Stream discharge, *Ecological effects, *Washington, Catchment areas, Agriculture, Storm runoff, Urban areas, Forest watersheds, Algae, Invertebrates, Water pollution sources.

Newaukum Creek drains 27.4 sq mi in south-central King County, Washington. Part of the drainage basin is in the foothills of the Cascade Mountains and is forested. The foothills usually consist of a thin layer of unconsolidated sediments underlain by volcanic rock. The remainder of the basin occupies an uneven plain that is mostly agricultural but contains part of the city of Enumclaw. Most of the plain is covered by mudflow material that is underlain by glacial drift. An analysis of one year of discharge data from stream gages near the mouth of Newaukum Creek and at the mouths of a forested, an agricultural, and an urban subbasin show that the annual contribution to base flow in Newaukum Creek from the urban subbasin (expressed as a percentage of precipitation) is less than from either the agricultural or forested subbasin. However, the contribution to storm runoff is larger. An examination of stream-water-quality data collected monthly during periods of base flow shows that the discharge-weighted mean annual concentrations of most constituents were highest at the urban site and lowest at the forested site. An examination of discharge-weighted mean concentrations in storm runoff that were obtained by regressing constituent washoff load against runoff volume show that the site with the highest or lowest concentration was different for the different constituents. Concentrations of bacteria, phosphorus and organic nitrogen were lowest at the forested site and the concentrations of suspended solids, ammonia, and dissolved nitrate-plus-nitrite were lowest at the urban site. Concentrations of suspended solids, nutrients, and bacteria were highest at the agricultural site, and concentrations of lead and zinc were highest at the urban site. Results of surveys of the natural benthic invertebrate populations and of algal growth on artificial substrates show that the biota at each site reflect the local environmental factors and water quality at each site. (Author's abstract)
W89-04648

EFFECTS OF SAND REMOVAL ON THE SHALLOW AQUIFER IN THE VICINITY OF THE CAMUY MANGROVE FOREST, PUERTO RICO,
Geological Survey, San Juan, PR. Water Resources Div.
A. Zack.
IN: Third Caribbean Islands Water Resources Congress. Proceedings of a Symposium held in St. Thomas, U.S. Virgin Islands, July 22-25, 1986. p 41-48, 3 fig, 7 ref.

Descriptors: *Environmental impact, *Puerto Rico, *Dunes, *Aquifers, *Wetlands, *Sand, *Mangrove swamps, Mangroves, Ecosystems, Seawater, Groundwater movement, Tidal flooding, Swamps.

Mangrove forests are very productive ecosystems which sustain valuable populations of fish, shell fish, and wildlife by producing large quantities of organic matter. The Camuy forest is a small (29 acre) mangrove community in Puerto Rico. It is characterized by an outstanding degree of development - apparently because of a strong, continuous freshwater input from groundwater seepage and a long, disturbance-free period from wind or wave action. The removal of aquifer material containing sand between the dunes and the Camuy mangrove probably affects the mangrove community only insofar as it has contributed to sand dune degradation. As sand dunes are lowered in height, the natural protection they provide to the mangrove forest is diminished. Seawater from high tides and waves is provided easier access to the forest by overtopping the dunes instead of being confined to the tidal channel. In addition the potential for sand-dune erosion exists which could wash sand into the forest, suffocating the trees. The effect that extraction has had on groundwater flow is minimal, and in itself, would not have been cause for concern with respect to maintenance of the mangrove community. The relative population of the four mangrove species and the vigor of the forest are related to relatively stable water levels in the swamp and to the cyclical nature of tidal flooding and gradual replacement by freshwater springflow as established over centuries of consistency. The rainfall accumulations in the sand dunes and the relation between head and water quality areally and with depth are significant hydrologically, but play a minor role in supporting the Camuy mangrove forest. Reducing freshwater seepage to the swamp by developing groundwater resources south of the mangrove or through drainage might increase salinity in the forest that would likely cause the death or reduction of the white mangrove and buttonwood species. (See also W89-04665) (Lantz-PTT)
W89-04672

THEORETICAL AND PRACTICAL ASPECTS OF INCREASING DRAINED PEATLAND LIFETIME,
Belorusskii Nauchno-Issledovatelskii Inst. Melioratsii i Vodnogo Khozyaistva, Minsk.
A. I. Mourashko.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu. Finland, 6-8 June 1988. Vol. 1. The Academy of Finland, Helsinki, Finland. 1988. p 100-106, 2 fig, 3 tab, 3 ref.

Descriptors: *Peat soils, *Peat bogs, *Drainage effects, *Peat, *Cultivation, *Wetlands, Soil profiles, Soil horizons, Soil compaction, Minerals, Filtration, Mathematical models, Theoretical analysis, Model studies, Marshes.

Peatland drainage and agricultural usage inevitably brings about decreasing the peat depth due to a number of physical and biochemical processes which account for the eventual disappearance of peat as a soil pattern. A most effective means to sustain a peat field involves deep plowing, with the layer turned out at 110-140 degrees. This results in a new soil profile with a sandy plowing horizon underlain with alternating peat and sand layers tilted at 45 degrees. The study findings are a mathematical model of sustainability of drained peatlands and a method of filtration computations for a drainage network over transformed quasimineral soils of man-made development. In comparison to the initial peatland, the resulting soil is more fertile and can be used for cultivating any crops. The transformation is a single-time operation with no need for repetition. The additional costs are paid off within one year if, for instance, potatoes are grown. However, in transforming peatlands there is need for a thorough knowledge of soil initial properties and stratigraphy, strict adherence to soil development and usage technology. (See also W89-04689) (Author's abstract)
W89-04705

GENERAL DESCRIPTION OF THE NURMES-STUDY,
North Karelian Water District Office, Joensuu (Finland).
M. Ahtiainen, A. L. Holopainen, and P. Huttunen.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu, Finland, 6-8 June 1988. Vol. 1. The Academy of Finland, Helsinki, Finland. 1988. p 107-121, 12 fig, 8 tab, 29 ref.

Descriptors: *Streams, *Wetlands, *Forestry, *Forest watersheds, *Clear-cutting, *Drainage effects, *Environmental effects, Water quality, Forest management, Meteorological data collection, Finland, Vegetation effects, Monitoring, Ecological effects, Hydrologic data collections, Cultivation.

General background information is presented on the long-term Nurmes-study, in which the effects of silvicultural measures on the environment are being investigated by a number of research teams. The project was started by monitoring the water quality and hydrology of six brooks from 1978 to 1981, when the work was expanded to incorporate the micrometeorology, hydrology and field level vegetation in more detail. The hydrobiology of the brooks was included in 1982 and experimental plots for forest research were established in 1983. The project employs the control basin method, all the basins having first been calibrated in their untouched state for almost five years. The first silvicultural measures, clear-cutting and draining, were carried out in two ways and to two extents, with two basins kept untouched throughout for control purposes. The second stage of the forestry work consisted of ploughing, draining and mounting in the clear-felled areas in 1986, followed by the planting of trees in 1987. Fertilization of the drained areas is planned to take place in 1988-1989. This is the first project in Finland in which water quality and hydrology are being studied in connection with hydrobiology, and in which micrometeorological and vegetational monitoring is being performed before and after forestry measures. The Nurmes-study is being carried out by research workers form the National Board of Waters and the Environment, the Forest Research Institute and the University of Joensuu, with financial support from the academy of Finland and the Maj and Tor Nessling Foundation. The National Board of Forestry is responsible for the practical implementation of the forestry measures. (See also W89-04689) (Author's abstract)
W89-04706

EFFECTS OF CLEAR-CUTTING AND FORESTRY DRAINAGE ON RUNOFF IN THE NURMES-STUDY,
National Board of Waters, Helsinki (Finland). Water Research Inst.
P. Seuna.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu, Finland, 6-8 June 1988. Vol. 1. The Academy of Finland, Helsinki, Finland. 1988. p 122-134, 18 fig, 5 tab, 8 ref.

Descriptors: *Environmental effects, *Forest hydrology, *Wetlands, *Runoff, *Clear-cutting, *Drainage effects, *Finland, Swamps, *Forest watersheds, Forestry, River basins, Streamflow, Runoff volume, Runoff rates, Forest hydrology, Forest management.

Clear-cuttings were carried out in two basins and drainage in two basins, while two catchments served as controls. Clear-cutting 55% of the area increased annual runoff by 15-20%, on average, or 5-8 mm per 10 cu m removed timber/ha. A clear increase of 14 to 57% was observed in the spring maximum runoffs and somewhat smaller increase in the summer maxima. The summer minima increased by 31-117%. Greater diurnal variation in runoff was observed after clear-cutting and the spring maxima were advanced by 4 to 7 days. The increases were greater in more swampy basins. When carried out in the traditional way, forestry drainage increased the minimum flows by 49 to 67%, the annual yield by 13% and to some extent the maximum runoffs. When undug spaces were left between the new drains and the natural channels, a slight decrease in the minimum runoffs was observed. The annual yield and the spring maximum did not increase, while some 25% increase in the summer maximum was recorded. (See also W89-04689) (Author's abstract)
W89-04707

RUNOFF FORMATION AND REGIME IN DRAINED PEATLAND FORESTS,
Akademiya Nauk SSSR, Moscow. Forest Research Lab.
For primary bibliographic entry see Field 2E.
W89-04708

BASIS OF THE HYDROLOGICAL BALANCE AND DRAINAGE TECHNIQUE OF BOGS FOR PEAT PRODUCTION,
Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). Poltto- ja Voiteluainelaboratorio.
For primary bibliographic entry see Field 2H.
W89-04710

DITCH CLEANING AND ADDITIONAL DITCHING IN PEATLAND FORESTRY: EFFECT ON GROUND WATER LEVEL,
Helsinki Univ. (Finland). Dept. of Peatland Forestry.
For primary bibliographic entry see Field 4A.
W89-04715

PRELIMINARY EFFECTS OF FOREST DRAINAGE IN ALBERTA, CANADA ON GROUNDWATER TABLE LEVELS AND STREAM WATER QUALITY,
Northern Forest Research Centre, Edmonton (Alberta).
G. R. Hillman.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu, Finland, 6-8 June 1988. Vol. 1. The Academy of Finland, Helsinki, Finland. 1988. p 190-196, 1 fig, 3 tab, 9 ref.

Descriptors: *Forest management, *Groundwater level, *Environmental effects, *Water quality, *Drainage effects, *Canada, Suspended sediment, Iron, Potassium, Aluminum, Wetlands, Drain spacing, Drawdown, Drainage ditches, Drainage practices, Water table fluctuations.

The effects of different ditch spacings on groundwater table levels were investigated on a coniferous swamp in Alberta as part of a wetland drainage and improvement for forestry program. Chemical water quality, suspended sediment, and specific conductance were measured upstream and downstream from points where drainage water entered the stream channel, to determine if sediment ponds and buffer zones were performing satisfactorily and to monitor changes in water quality. The average water table profiles before and after ditching indicated that ditching created a drawdown of about 30 cm, 2-3 m from the ditch. The average depth to water table after ditching increased by 22, 18, and 10 cm for 30- 40- and 50-m spacings, respectively. No significant differences were detected between upstream and downstream levels for 13 of 16 inorganic elements investigated. Downstream changes in specific conductance and levels of suspended sediment were also non-significant. Ditching increased the levels of iron in the stream but appeared to lower the levels of aluminum and potassium. The results indicated that sediment ponds and buffer zones in the ditch network were functioning well and that stream water quality was not being impaired. (See also W89-04689) (Author's abstract)
W89-04716

IMPACTS OF DRAINAGE FOR FORESTRY ON RUNOFF AND WATER CHEMISTRY,
Sveriges Lantbruksuniversitet, Uppsala. Dept. of Forest Soils.
L. Lundin.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu, Finland, 6-8 June 1988. Vol. 1. The Academy of Finland, Helsinki, Finland. 1988. p 197-205, 1 fig, 2 tab, 31 ref.

Descriptors: *Forest management, *Wetlands, *Drainage ditches, *Drainage effects, *Runoff, *Water quality, Chemical properties, Peat bogs, Sweden, Hydrologic budget, Peat, Hydrogen ion concentration, Fens, Alkalinity, Phosphorus, Nitrogen, Sulfates, Nutrients, Forestry.

Drainage in forestry concerns both peatlands and wet mineral soils. In Sweden this drainage today is concentrated on mineral soils, i.e., clear-cut areas more or less waterlogged after clearfelling. The areas of interest to forest drainage often have organic soil horizons with peat character, and true peat areas often exist in connection with these areas. Drainage of larger peatlands is also performed. The drainage activities affect, among other things, the quantity and chemical composition of runoff. Effects of drainage on runoff and chemical composition of streamwater were studied together with calculations of water balance and chemical budgets. The investigations were performed at a bog, a calcareous fen and two small sedge fens. These sedge fens showed similarities to mineral soil areas while the many small peatland units required many ditches penetrating the mineral soil. The investigations were performed as comparative studies before and after drainage between two peatland basins, of which one comprised a control area and the other was drained. The results show some similar effects of drainage at the different sites and some effects varying with both site and time. The distribution of precipitation and snowmelt influenced the results. Drainage influenced runoff with both increasing and decreasing mean and high discharges while the low discharges mainly increased. During some winters the low flow ceased. The changes of chemical composition of runoff were affected by the lagg-ditches penetrating the mineral soil beneath the peat. This often resulted in increased pH, alkalinity and concentrations of cations but also of sulfate. Effects on phosphorus and nitrogen varied with site. Nitrogen increased at the fens but decreased at the bog. Increases in the leachates of total-P and total-N were often found. Chemical budgets revealed net losses of HCO3, K, Ca, Cl, Al and organic C and retentions of H and N whereas variations occurred for SO4 and P. (See also W89-04689) (Author's abstract)
W89-04717

EFFECTS OF CLEAR-CUTTING AND FORESTRY DRAINAGE ON WATER QUALITY IN THE NURMES-STUDY,
North Karelian Water District Office, Joensuu (Finland).
M. Ahtiainen.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu, Finland, 6-8 June 1988. Vol. 1. The Academy of Finland, Helsinki, Finland. 1988. p 206-219, 5 fig, 5 tab, 32 ref.

Descriptors: *Forest management, *Environmental effects, *Wetlands, *Drainage effects, *Clear-cutting, *Peat soils, *Water quality, Chemical oxygen demand, Color, Water temperature, Phosphorus, Leaching, Phosphates, Drainage ditches, Drainage practices, Erosion, Suspended solids, Logging, Nutrients, Forestry, Runoff.

The water quality and runoff of six small forest brooks have been studied since 1978. All brooks were investigated in their untouched state for nearly five years, after which clear-cutting and forestry drainage were carried out in two different ways and to two different extents on four of the basins, leaving two undisturbed throughout, as control basins. Water temperature, color and chemical oxygen demand values increased immediately after clear-cutting. Large-scale cutting on peat soil increased the 3-year mean leaching of organic matter (COD) by 73%, the corresponding increase after cutting on mineral soil with the protective zone left alongside the brook being 23%. The large-scale cutting on peat soil created a significant increase in the rates of leaching of total and phosphate phosphorus, the first-year values of 55 kg/sq km/yr (tot-P) and 33 kg/sq km/yr (PO4-P) being four and five times the leaching losses during the calibration period. These rates rose still higher in the second year to 75 kg/sq km/yr (tot-P) and 55 kg/sq km/yr (PO4-P), but decreased to 47 kg/sq km/yr (tot-P) and 28 kg/sq km/yr (PO4-P) in the third year. The phosphorus was predominantly in soluble form. The smaller-scale cutting on mineral soil increased the load of total phosphorus by one third in the first two years. Apparently reasons for the remarkable increase in phosphorus were the rise in the groundwater table, followed by accelerated ground and soil water flow, decay of plant material, release of phosphorus from humus due to increased solar radiation, reductive conditions and leaching of nutrients from the tracks left by the heavy machinery removing the timber. In one of the two basins where both clear-cutting and ditching were carried out, the annual load of suspended solids increased 4-fold in relation to the control value during the first three years. Ditching of the soil in the other basin, which is more sensitive to erosion, caused an increase in suspended solids to a level 17 times higher than during the calibration years. (See also W89-04689) (Author's abstract)
W89-04718

ORGANIC CARBON DYNAMICS IN SMALL BROOKS BEFORE AND AFTER FOREST DRAINAGE AND CLEAR-CUTTING,
Joensuu Univ. (Finland). Karelian Inst.
A. Hovi.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in temperate and Cold Regions. Joensuu, Finland, 6-8 June 1988. Vol. 1. The Academy of Finland, Helsinki, Finland. 1988. p 220-231, 5 fig, 1 tab, 29 ref.

Descriptors: *Wetlands, *Environmental effects, *Drainage effects, *Organic carbon, *Clear-cutting, *Forest watersheds, *Peat soils, Drainage practices, Water table fluctuations, Finland, Suspended solids, Dissolved solids, Runoff, Particulate matter.

Long and short-term variation in particulate organic carbon (POC), dissolved organic carbon (DOC) and total organic carbon (TOC) and patterns of concentration changes were examined in four brooks draining from small basins in the Nurmes-study area. The drainage basins were in their natural state until 1983, when one was clear-felled, one drained and one clear-felled and drained. One basin was left unaffected for control purposes. Data from intensive sampling (samples taken every 2-6 hours) during rainy periods showed different vari-

ations in carbon concentrations before and after these forestry measures. The timing and patterns of the carbon dynamics changed depending on the measures undertaken, although the proceeding weather conditions also determined the nature of the response. Small amounts of rainfall after a long dry spell caused only minor changes in carbon concentrations, while POC and DOC increased most at times of intensive rainfall. As a whole, draining changed the organic carbon variation most. The dynamics of long-term, i.e. seasonal, variation in carbon flow were basically dependent on groundwater table levels, while the storm flow governed the short-term variation. (See also W89-04689) (Author's abstract)
W89-04719

EFFECTS OF SILVICULTURAL MEASURES ON PRIMARY PRODUCTION IN FOREST BROOKS,
Joensuu Univ. (Finland). Dept. of Biology.
P. Huttunen, A. L. Holopainen, and A. Hovi.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu, Finland, 6-8 June 1988. Vol. 1. The Academy of Finland, Helsinki, Finland. 1988. p 239-248, 4 fig, 3 tab, 25 ref.

Descriptors: *Forest management, *Stream biota, *Wetlands, *Environmental effects, *Clear-cutting, *Drainage effects, *Forest watersheds, *Primary productivity, Streams, Drainage ditches, Bacteria, Algae, Logging, Ecological effects, Peat soils.

The effects of clear-cutting of forest and drainage on the ecology of small forest brooks are studied as a part of the multidisciplinary Nurmes research project. Intensified clear-cutting on mainly peaty soils evoked significant changes in both algal primary production and bacterial production. The total in vitro primary production a year after winter clear-cutting (1983) was 14 times higher than before it (1982), and three years later it was still three times the natural background value. Bacterial production, as measured by CO2 dark fixation in vitro, increased later than primary productivity and remained above the normal value at least up to 1986. Algal biomass increased to 47 times the background value and returned to normal, together with primary production, only in 1986. The number of species was impoverished at the time of maximal biomass, with Chlamydomonas, Cryptomonas and Euglenales flagellates dominant. Small-scale felling on mineral soil with an uncut protective zone left around the brook did not cause significant changes in primary producers. Primary production in the ditching-basin (13% of the drainage area) increased 3-fold in the two first years. CO2 dark fixation did not rise until later, in 1985 and 1986. Algal biomass increased 5-fold after treatment, and returned to normal in 1986. Primary production in a basin, which was both clear-felled and ditched, increased only gradually to a maximum of six-fold in 1985, but decreased to the basal level in 1986. Bacterial production did not increase significantly until 1985, but then remained higher than before. Algal biomass increased greatly (150-fold) in the first year, but in contrast to production values, fell again the next year (1984). Changes in algal biomass and species composition could still be seen in 1986. (See also W89-04689) (Author's abstract)
W89-04721

EFFECTS OF HARVESTING ON REGENERATION AND BIOLOGICAL PRODUCTION OF PHRAGMITES AUSTRALIS IN WETLANDS,
Tohoku Univ., Sendai (Japan). Biological Inst.
Y. Kurihara, and T. Suzuki.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in temperate and Cold Regions. Joensuu, Finland, 6-8 June 1988. Vol. 1. The Academy of Finland, Helsinki, Finland. 1988. p 249-255, 6 fig, 1 tab, 7 ref.

Descriptors: *Flood control, *Sludge disposal, *Wetlands, *Marsh plants, *Primary productivity, Biomass, Nutrients, Phosphorus, Nitrogen, Environmental effects, Regeneration, Marshes, Plant growth.

Since reed, Phragmites australis, grows so densely as to constitute an obstacle in rivers during the flood season, its removal becomes a highly important step in the control of the flow of water. Another reason for harvesting the reed is the fact that it incorporates fairly large amounts of nitrogen, phosphorus and other nutrients from the polluted water and nutrient-rich mud substratum, thus benefiting the environment. The regrowth of reeds, Phragmites australis, harvested at different stages of the growing season was examined in pots and in situ to establish the best time for harvesting. The tendency for height and biomass in plots harvested later in the season to increase was recognized. For cutting 30 cm above the water surface, regrowth after one year was quite satisfactory. In the pot experiment, the amounts of nitrogen and phosphorus in the underground parts of reeds were very low at the early stages and rose remarkably at about 100 days after supplying nutrients, corresponding to August in situ. Therefore, harvesting in August by cutting stems above the water level was found to maximize total biomass that could be removed from the stand. However, there still remains the problem as to how to use the harvested material. Its application to agricultural land with sludge discharged from a sewage treatment plant is expected to become an important means for disposing of sludge and using this material. (See also W89-04689) (Author's abstract)
W89-04722

SHORT-TERM CHANGES IN VEGETATION ON PINE MIRES AFTER DRAINAGE FOR FORESTRY,
Office of Environmental Protection, Kouvola (Finland).
H. Kurimo, and A. Uski.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu, Finland, 6-8 June 1988. Vol. 1. The Academy of Finland, Helsinki, Finland. 1988. p 256-269, 7 fig, 17 ref.

Descriptors: *Environmental effects, *Mires, *Vegetation effects, *Drainage effects, *Forestry, *Pine trees, *Wetlands, Species composition, Water table fluctuations, Marshes, Regression analysis, Mathematical studies, Species diversity, Succession, Ecological effects.

The vegetation on three pine mires was examined every year during a 5-year period. Two of the mires were drained for forestry during the third year, while the third mire remained untouched. A strategy consisting of several independent analysis methods was created for detecting different aspects reflecting the change in vegetation. This was used to reconstruct successive series depicting paths of development in the vegetation after the drainage of initially different mire types. The results obtained by these methods were highly parallel, indicating the same trend in each case. Even though the change in vegetation was still relatively small three years after draining it could be clearly detected on both drained mires. The change in floristic composition was so small that the frequencies of the species related to the plots very seldom changed. The change could mostly be detected only from the coverage of certain indicator species. The slight alteration in the vegetation observed after drainage was best explained by the previous vegetation, explanatory power about .80 and .90 for the drained mires and about .95 for the control plot. The remaining 5% of the variation in the case of the control plot can be considered normal stochastic variation in vegetation caused by general factors affecting the entire area. The lowering of the groundwater table was found to be the most important factor responsible for the change in vegetation, especially where initially wet and semi-wet sites were concerned. The vegetation on the hummocks remained almost unchanged after draining. Post-drainage development tended to operate in the direction of a more uniform vegetation. (See also W89-04689) (Author's abstract)
W89-04723

ENVIRONMENTAL ASPECTS OF PEAT SILTATION ARISING FROM INTENSIVE PEATLAND EXPLOITATION IN IRELAND,
Irish Peat Development Authority, Dublin. Civil Engineering Div.
J. Feeley, and J. M. Welsby.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu, Finland, 6-8 June 1988. Vol. 1. The Academy of Finland, Helsinki, Finland. 1988. p 270-276, 7 ref.

Descriptors: *Peat, *Silting, *Erosion, *Ireland, *Environmental effects, *Wetlands, Navigation, Peat, Sedimentation, Legal aspects, Erosion control, Settling basins, Desilting basins.

The effects of exploitation of the Bord na Mona peatlands in Ireland on the peat siltation of the Shannon River catchment are examined. Excessive peat solids, while not toxic, may reduce the grass yields of grasslands. Significant settlement of peat solids will affect the storage capacity of the backwater systems of the river. Accumulations of peat silt may also hinder navigation. Studies on the aquatic effects of peat siltation showed that vegetative abundance and diversity are diminished near mounds of sediment. Where the aquatic plant community is destroyed, there is also a reduction in the trophic stages of the food chain which depend on the plants for shelter, food, and spawning medium. Methods of control of peat siltation include effluent quality control measures on all of the associated 33,000 ha of bogland. Settling ponds are being revised according to current knowledge to afford effective desilting. Settlement theory and practical experience for the design of current desilting ponds is examined. Under the Peco system of milled peat production, losses arising from peat siltation, its correction and control are quantified. Although current legislative policy and environmental control measures exempt Bord na Mona from various provisions to protect the environment, the peat producers are fully committed to the control of peat silt in all of its effluent waters. Adopted standards will limit effluent suspended solids to under 100 mg/l and retain over 90% of peat silt. (See also W89-04689) (Geiger-PTT)
W89-04724

PRELIMINARY RESULTS OF A MOLE DRAINAGE EXPERIMENT IN PIIPSANNEVA PEAT HARVESTING SITE,
Vapo Oy, Jyvaskyla (Finland).
For primary bibliographic entry see Field 4A.
W89-04725

EFFECTS OF PEATLAND FORESTRY MANAGEMENT AND FUEL PEAT MINING IN LAKE ILAJANJARVI, EAST FINLAND: A PALEOLIMNOLOGICAL STUDY,
Joensuu Univ. (Finland). Karelian Inst.
H. Simola, P. Huttunen, P. Uironen-Simola, P. Selin, and J. Merilainen.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu, Finland, 6-8 June 1988. Vol. 1. The Academy of Finland, Helsinki, Finland. 1988. p 285-290, 2 fig, 1 tab, 10 ref.

Descriptors: *Peat, *Water pollution effects, *Wetlands, *Paleolimnology, *Environmental effects, *Forest management, Diatoms, Water quality, Species diversity, Eutrophic lakes, Ecological effects, Finland, Eutrophication, Drainage effects.

The recent development of Lake Ilajanjarvi in East Finland was studied by paleolimnological analyses. The sediment was dated by Pb210 (CRS-model) and by annual varves that have been formed since the year 1966 due to prevailing anoxia in the deepest part of the lake. Biostratigraphic analyses of diatoms and Cladocera indicate prominent eutrophication of the lake, especially after the mid-1970's (mass development of the diatom Melosira ambigua in the 1976 varve and since; appearance of Bosmina longirostris as a new species and increase of Chydorus sphaericus). The stratigraphic assemblages were ordinated by DCA together with reference assemblages collected from the surface sediments of a number of eastern Finnish lakes. As judged by diatoms, the ecosystem of Ilajanjarvi has changed from that of a dys-

oligotrophic forest lake towards resemblance of some naturally eutrophic lakes, of which one is situated in the Siilinjarvi area where bedrock apatite enriches the soil with phosphorus. Change of the cladoceran assemblages is not so thorough, but nevertheless apparent in the DCA-ordination also. Peatland management appears to have caused the eutrophication of Ilajanjarvi: drainage and fertilization of peatlands since 1957 and development of a fuel peat mining area since 1976 have been the major disturbing factors on the lake's largely paludified 200-sq-km drainage area. (See also W89-04689) (Author's abstract)
W89-04726

ENVIRONMENTAL ASSESSMENT OF PEATLAND DEVELOPMENT OPERATIONS IN NEWFOUNDLAND,
Lakehead Univ., Thunder Bay (Ontario). Dept. of Civil Engineering.
U. S. Panu.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu, Finland, 6-8 June 1988. Vol. 1. The Academy of Finland, Helsinki, Finland. 1988. p 291-300, 4 fig, 2 tab, 10 ref.

Descriptors: *Newfoundland, *Wetlands, *Water quality management, *Peat bogs, *Canada, *Environmental effects, Settling basins, Suspended solids, Peat, Runoff, Drainage effects, Drainage ditches, Water pollution prevention, Maximum flow.

The peatland resources are distributed throughout Newfoundland with varying degree of quality and quantity of mineable peat for commercial operations. Among other types of peatlands, the domed and blanket bogs are most frequently found in central and southern Newfoundland. Two peat harvesting projects, one each in an area rich in domed bogs and in an area rich in blanket bogs, were initiated to explore and evaluate the viability of peat development technology in Newfoundland. Both projects used different peatland drainage strategy and peatland harvesting technology. That is, the project in domed bog utilized milled peat harvesting techniques and the project in blanket bog used the sod peat harvesting techniques. These projects were monitored on a continuous basis for the purpose of assessing environmental impacts on receiving waters. Both projects have been found to be viable within the stipulated limits of environmental regulations and are presently being allowed to operate as private enterprises. The results of various analyses carried out on the data obtained from the project located in the domed bog rich area of central Newfoundland are presented. The peak flows in peat harvesting area are found to increase by two to five fold. The results also indicate that significant changes do occur in runoff volumes and water quality parameters. The suspended peat load is found to increase considerably due to peat mining activities. The peat settling basins of dimension 6 by 2 by 1 m with a bimonthly peat removal frequency are recommended at outlets of ditches draining 100 ha of peat mining area. The assimilative capability of receiving water at the project site was found adequate. (See also W89-04689) (Author's abstract)
W89-04727

INFLUENCE OF DRAINAGE AND DEVELOPMENT OF OVERWETTED LANDS ON QUANTITATIVE AND QUALITATIVE NATURAL WATER INDICES,
Ukrainskii Nauchno-Issledovatel'skii Inst. Gidrotekhniki i Melioratsii, Kiev (USSR).
V. Y. Alekseyevsky, N. I. Ivanushkina, and G. P. Ryabtseva.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu, Finland, 6-8 June 1988. Vol. 1. The Academy of Finland, Helsinki, Finland. 1988. p 317-320, 2 fig, 1 tab.

Descriptors: *Drainage effects, *Wetlands, *Land reclamation, Land use, Phosphorus removal, Groundwater movement, Chemical properties, Minerals, Fertilizers, Herbicides, Runoff, Water table fluctuations, Forest watersheds, Environmental effects.

The influence of land reclamation on the hydrological characteristics of the territory, chemical composition of natural waters and substance removal from improved lands is not homogeneous in time and space within one region. Physical peculiarities of reclamation systems affect quantitative indices; the application of fertilizers, chemical meliorants and herbicides are most influential at the stage of intensive land development; while the details of regional development influence qualitative indices. As a result of a twenty-year study of quantitative and qualitative natural water indices, three periods of their formation have been singled out: the period of reclamation system construction, when all indices change more the natural conditions; the period of system under stabilization after construction completion, when all indices are gradually levelling; and, finally, the period of land reclamation development when chemical load the territory, with all its consequences, sharply increases. Under long-term system operation in the Ukrainian Woodland the groundwaters lie at a depth of 0.5-1.5 m within the lowlands and up to 2-3 m in the lowland margins. Initially, the mineralization of natural waters in the Ukranian Woodlands was up to 1.0 g/l; twenty years or more after the beginning on land development, the mineralization increases to 1.5 times its former composition. The volume of normalized biogenic substance removal is mainly determined by seasonal runoff variations. Potassium, as the most soluble ion, has the greatest removal (up to 6 kg/day/ha), and phosphorus the least (up to 0.01 kg/day/ha). Intensive land reclamation, and the changes in natural conditions accompanying it, must be under constant control with the aim of taking timely measures for avoiding negative impacts. (Author's abstract)
W89-04730

PROCEEDINGS OF THE INTERNATIONAL SYMPOSIUM ON THE HYDROLOGY OF WETLANDS IN TEMPERATE AND COLD REGIONS.
For primary bibliographic entry see Field 2H.
W89-04731

DRAINAGE EFFECT ON THE ENVIRONMENT,
Gosudarstvennyi Gidrologicheskii Inst., Leningrad (USSR).
For primary bibliographic entry see Field 2H.
W89-04740

WATER TABLE PROFILES OF DRAINED FORESTED AND CLEARCUT PEATLANDS IN NORTHERN ONTARIO, CANADA,
Great Lakes Forestry Research Centre, Sault Sainte Marie (Ontario).
For primary bibliographic entry see Field 2H.
W89-04741

WATER QUALITY OF PEATLANDS AND MAN'S INFLUENCE ON IT,
Tampere Water and Environmental District (Finland).
For primary bibliographic entry see Field 5B.
W89-04742

EFFECT OF PEAT PRODUCTION ON WATER QUALITY AND BACTERIOPLANKTON IN THE DRAINAGE BASIN OF THE RIVER KIIMINKIJOKI,
Oulu Univ. (Finland). Dept. of Botany.
For primary bibliographic entry see Field 2H.
W89-04743

CHARACTERIZATION OF PRODUCED WATERS FROM NATURAL GAS PRODUCTION OPERATIONS. EXECUTIVE SUMMARY,
ERT, Pittsburgh, PA.
For primary bibliographic entry see Field 5A.
W89-04886

SOUTH LAKE TAHOE QUADRANGLE: VEGETATION MAP,
Geological Survey, Carson City, NV. Water Resources Div.
For primary bibliographic entry see Field 7C.
W89-04907

EFFECTS OF PROPOSED HIGHWAY EMBANKMENT MODIFICATIONS ON WATER-SURFACE ELEVATIONS IN THE LOWER PEARL RIVER FLOOD PLAIN NEAR SLIDELL, LOUISIANA,
Geological Survey, Baton Rouge, LA. Water Resources Div.
J. J. Gilbert, and R. E. Schuck-Kolben.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4129, 1987. 36p, 13 fig, 7 tab, 13 ref.

Descriptors: *Flooding, *Flood plains, *Highway effects, *Embankments, *Louisiana, River basins, Flood damage, Finite element method, Model studies, Bridge design, Backwater, Flood control.

Major flooding in the lower Pearl River basin in recent years has caused extensive damage to homes and highways in the area. In 1980 and 1983, Interstate Highway 10 and U.S. Highway 190 were overtopped. In 1983, the Interstate Highway 10 crossing was seriously damaged by the flood. The U.S. Geological Survey, in cooperation with the Louisiana Department of Transportation and Development, Office of Highways, used a two-dimensional finite-element surface-water flow model to evaluate the effects the proposed embankment modifications at Interstate Highway 10 and U.S. Highway 90 on the water-surface elevations in the lower Pearl River flood plain near Slidell, Louisiana. The proposed modifications that were considered for the 1983 flood are: (1) Removal of all highway embankments, the natural condition, (2) extension of the West Pearl River bridge by 1,000 feet at U.S. Highway 90, (3) construction of a new 250-foot bridge opening in the U.S. Highways 190 and 90, west of the intersection of the highways. The proposed highway bridge modifications also incorporated lowering of ground-surface elevations under the new bridges to sea level. The modification that provided the largest reduction in backwater, about 35 percent, was a new bridge in Interstate Highway 10. The modification of the West Pearl River bridge at U.S. Highway 90 and replacement of the bridge in U.S. Highway 190 provide about a 25% reduction in backwater each. For the other modification conditions that required structural modifications, maximum backwater computed on the west side of the flood plain ranges from 0.0 to 0.8 foot and on the east side from 0.0 to 0.6 foot. Results show that although backwater is greater on the west side of the flood plain than on the east side, upstream of highway embankments, backwater decreases more rapidly in the upstream direction on the west side of the flood plain than on the east side. Analysis of the proposed modifications indicates that backwater would still occur on the east and west sides of the flood plain, but values would be less than those computed with highway embankments in place. (Author's abstract)
W89-04912

DESCRIPTION OF THE HYDROLOGIC SYSTEM AND THE EFFECTS OF COAL MINING ON WATER QUALITY IN THE EAST FORK LITTLE CHARITON RIVER AND THE ALLUVIAL AQUIFER BETWEEN MACON AND HUNSTVILLE, NORTH-CENTRAL MISSOURI,
Geological Survey, Rolla, MO. Water Resources Div.
For primary bibliographic entry see Field 5B.
W89-04934

EFFECTS OF LAND USE ON GROUNDWATER QUALITY IN CENTRAL FLORIDA--PRELIMINARY RESULTS: U.S. GEOLOGICAL SURVEY TOXIC WASTE--GROUND-WATER CONTAMINATION PROGRAM,
Geological Survey, Tallahassee, FL. Water Resources Div.

For primary bibliographic entry see Field 5B.
W89-04936

GEOHYDROLOGY AND POTENTIAL HYDROLOGIC EFFECTS OF UNDERGROUND COAL MINING IN THE RAPID CREEK BASIN, MESA COUNTY, COLORADO,
Geological Survey, Denver, CO. Water Resources Div.
T. Brooks.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4172. 1986. 28p, 6 fig, 5 tab, 19 ref 1 plate in pocket.

Descriptors: *Coal mining, *Subsidence, *Water quality, *Geohydrology, *Mining effects, Aquifers, Stream discharge, Specific conductivity, Groundwater movement, Hydrogen ion concentration, Evapotranspiration.

The U.S. Bureau of Land Management may lease additional coal tracts in the Rapid Creek basin, Colorado. Springs in this basin are used as a water supply for the town of Palisade. The geohydrology of the basin is described and the potential hydrologic effects of underground coal mining in the basin summarized. Geologic formations in the basin consists of Cretaceous sandstone and shale, Tertiary sandstone, shale, and basalt, and unconsolidated deposits of Quaternary age. Some sandstone and coal beds are permeable, although bedrock in the basin typically is a confining bed. Unconsolidated deposits contain aquifers that are the source of spring discharge. Stream discharge was measured on Rapid and Cottonwood Creeks, and inventories were made of 7 reservoirs, 25 springs, and 12 wells. Specific conductance of streams ranged from 320 to 1,050 microsiemens/cm at 25C; pH ranged from 7.8 to 8.6. Specific conductance of springs ranged from 95 to 1,050 microsiemens/cm at 25C; pH ranged from 6.8 to 8.3. Discharge from the basin includes about 18,800 acre-ft/yr as evapotranspiration, 1,300 acre-ft/yr as springflow, 1,280 acre-ft/yr as streamflow, and negligible groundwater flow in bedrock. With appropriate mining methods, underground mining would not decrease flow in basin streams or from springs. The potential effects of mining-caused subsidence might include water-pipeline damage and temporary dewatering of bedrock adjacent to coal mining. (Author's abstract)
W89-04942

RECONNAISSANCE OF HYDROLOGY, LAND USE, GROUND-WATER CHEMISTRY, AND EFFECTS OF LAND USE ON GROUND-WATER CHEMISTRY IN THE ALBUQUERQUE-BELEN BASIN, NEW MEXICO,
Geological Survey, Albuquerque, NM. Water Resources Div.
For primary bibliographic entry see Field 5B.
W89-04944

THICKNESS AND HYDROGEOLOGY OF AQUIFERS AND CONFINING UNITS BELOW THE UPPER GLACIAL AQUIFER ON LONG ISLAND, NEW YORK,
Geological Survey, Syosset, NY. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-04945

ESTIMATING PEAK DISCHARGES, FLOOD VOLUMES, AND HYDROGRAPH SHAPES OF SMALL UNGAGED URBAN STREAMS IN OHIO,
Geological Survey, Columbus, OH. Water Resources Div.
For primary bibliographic entry see Field 2E.
W89-04959

EFFECTS OF DRAINAGE ON CROPS AND FARM MANAGEMENT,
Institute for Land and Water Management Research, Wageningen (Netherlands).
R. A. Feddes.
Agricultural Water Management AWMADF, Vol. 14, No. 1-4, p 3-18, August 1988. 11 fig, 3 tab, 45 ref.

Descriptors: *Drainage, *Drainage effects, *Crop yield, *Farm management, *Agricultural hydrology, *Soil-water-plant relationships, Drainage engineering, Hydrologic models, Computer models, Soil water, The Netherlands.

A review is given of the history and present state of drainage theory and its applications in the Netherlands. The theoretical framework evolved form the steady-state cases studied by Hooghoudt and the corresponding criteria. Later on, non-steady conditions and criteria were introduced. Both methods lead to almost the same conclusions regarding drain spacings. To establish the steady and non-steady drainage criteria experimental fields were used. Groundwater depth, though easy to measure, is a poor criterion for the conditions encountered by growing crops. Therefore, more recently, models have been developed to simulate the moisture regime of the root zone and the soil surface. Several such models are described; they are applied to various problems ranging from soil workability to length of growing season and crop response to drought in summer. In this way the effects of drainage depth and drain spacing can be investigated in far more detail than would be possible from field experiments. Data obtained by remote sensing techniques data can be interpreted in terms of moisture status in the field. This independent method can be used to check or to calibrate the results obtained from numerical models. (Author's abstract)
W89-05107

EFFECTS OF SUBSURFACE DRAINAGE ON HEAVY HYDROMORPHIC SOIL IN THE NELINDVOR AREA, YUGOSLAVIA,
Institut za Vodoprivredu Jaroslav Cerni, Belgrade (Yugoslavia).
N. Plamenac.
Agricultural Water Management AWMADF, Vol. 14, No. 1-4, p 19-27, August 1988. 8 fig, 3 tab, 4 ref.

Descriptors: *Agricultural hydrology, *Subsurface drainage, *Clays, *Drainage effects, *Soil water table, *Yugoslavia, Tile drainage, Drainage programs, Crop yield, Soil physical properties, Drain spacing, Waterlogging, Hydraulic conductivity, Backfill, Subsoil drainage, Mole drainage.

The establishment in 1958 of experimental fields with subsurface drainage on clay soils under different natural conditions and frequently with excess water, marked the beginning of a period of investigating the most important parameters that determine the improvement of the water-air regime in the soil. One of the experimental fields installed in 1968 is the Nelindvor field, situated in the Drava valley close to the city of Osijek. The investigations carried out in this field concern the effect of various drainage variants on the improvement of the soil water regime, yield increase, and effect on soil structure and workability. Tile drainage with large spacings (20-50 m) applied in the Nelindvor experimental field on very deep heavy clay soil proved to be highly effective when combined with measures like subsoiling and moling. The lowering of the groundwater level to a depth of 50 cm in the critical spring period took 3 days for drains spaced at 20-30 m. The longer duration for the larger spacings negatively affected tillage and reduced maize and wheat yields. When filter materials were applied together with a highly permeable connecting layer in the trench up to the arable layer, waterlogging disappeared within 2 days. The hydraulic conductivity of the soil and the bulk density in the trench with gravel backfill showed favorable values even after 5 years, whereas the soil in the trenches without backfill compacted quickly. The soil water flow in the original soil near the trench is unfavorable without moling or subsoiling to a depth of about 60 cm. The physical and thermal properties of the soil were improved, yield of all crops increased and considerable savings in the machine work and labor were achieved if compared with undrained conditions. The results obtained with the application of clay tiles and corrugated PVC pipes in the Drava valley, combined with different envelope materials provided more reliable and cheaper technical solutions for subsurface drainage. (Vernooy-PTT)
W89-05108

INFLUENCE OF WATER LEVEL MANAGEMENT AND GROUNDWATER QUALITY ON VEGETATION DEVELOPMENT IN A SMALL NATURE RESERVE IN THE SOUTHERN GELDERSE VALLEI (THE NETHERLANDS),
Agricultural Univ., Wageningen (Netherlands). Dept. of Land and Water Use.
D. van der Hoek, and S. van der Schaaf.
Agricultural Water Management AWMADF, Vol. 14, No. 1-4, p 423-437, August 1988. 8 fig, 4 tab, 12 ref.

Descriptors: *Drainage effects, *Groundwater management, *Vegetation effects, *Wetlands, *The Netherlands, *Water table decline, Water management, Groundwater levels, Water quality, Impaired water quality.

In many small wetland reserves in the Netherlands the vegetation is changing slowly as a result of qualitative and quantitative changes in hydrological conditions. An analysis is given of the relation of the changed regional geohydrological system to the changing situation in a small reserve where the original vegetation was a seepage dependent Cirsio Molinietum. Seepage from an underlying artesian aquifer has become smaller in the 20th century as a result of afforestation of the infiltration area and of increased pumping of groundwater. Measures to protect the original vegetation consisted of the installation of a small windmill to pump in water from the Grift into the reserve, construction of a low embankment along the eastern and the southern edges to allow water conservation during the winter, and a ditch along the embankment to divert a possible inflow of polluted (ground) water around the reserve into the Grift. These have caused an increased liability to inundation by eutrophic and polluted water in the largest part of the reserve. Although pumping of water was discontinued in later years, the inlet was never closed and in periods of high Grift levels inundation of parts of the reserve may occur. Measures for a better preservation of the vegetation suggested are: (1) undo the previous measures in order to prevent inundation by Grift water and prevent conservation of rain water. A drier situation at times in the central part may be the consequence, but this will cause a slower degradation of the vegetation; (2) create a buffer zone around the reserve to decrease the hydrological dependence on the surrounding area; (3) increase of the supply of lighogenic water by drilling one or two wells into the artesian aquifer, combined with a proper water level management system. (Vernooy-PTT)
W89-05147

SMALL WATER BODIES AND WETLANDS: THE INFLUENCE OF WATER LEVEL MANIPULATION ON METAPHYTON PRODUCTION IN A TEMPERATE FRESHWATER MARSH,
Delta Waterfowl and Wetlands Research Station, Portage la Prairie (Manitoba).
For primary bibliographic entry see Field 6G.
W89-05192

EFFECT OF DEFORESTATION ON ORGANIC DEBRIS DAMS,
Yale Univ., New Haven, CT. Dept. of Biology.
L. O. Hedin, M. S. Mayer, and G. E. Likens.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IV TLAP, Vol. 23, No. 2, p 1135-1141, August 1988. 3 fig, 22 ref.

Descriptors: *Forest management, *Dams, *Sediment transport, *Clear-cutting, *Debris dams, Organic debris, Waterfalls, Pools, Deforestation.

The effects of deforestation on the abundance and persistence of dams, and on sediment transport in several small streams were examined. The study was conducted in first and second order streams draining a second growth northern hardwood forest at the Hubbard Brook Experimental Forest,

in the White Mountains of New Hampshire. The streams drain similar, parallel watersheds, have average channel slopes ranging from 6 to 19 degrees and exhibit stair-step channel morphologies with organic debris dams creating a series of small waterfalls with associated pools. There was a large, but somewhat delayed, effect of deforestation on the abundance of organic debris dams in the streams. Two years after deforestation, the density of dams had not changed. During the third year, there was a large decrease in the density of dams. Abundances of dams were even further depressed 19 and 20 years after deforestation. The export of sediment peaked in the third year after deforestation. A lag period is suggested before the debris dams start decreasing. The abundance of organic debris dams decreases until tress from the regrowing forest are large enough to create dams when they fall across the stream channel. The changes in abundance of debris dams affects the transport of sediment. The results of the study support the hypothesis that deforestation has a major effect on the abundance of organic debris dams. Deforestation in the northern hardwood forest affected abundances of debris dams for an extended period of time, possibly 100 years or more. In a forested landscape, it is expected, at any one time, to find streams with different abundances of debris dams and patterns of sediment transport depending on the history and spatial variability of disturbance in the landscape. (Davis-PTT)
W89-05200

ECOSYSTEM ANALYSIS OF THE CALCASIEU RIVER/LAKE COMPLEX (CALECO).
McNeese State Univ., Lake Charles, LA.
Available from the National Technical Information Service, Springfield, VA 22161, as DE88-002683. Price codes: A18 in paper copy, A01 in microfiche. Report No. DOE/EP/31111--1-Vol. 1, June 26, 1987. 403p. DOE Grant DE-FG01-83EP31111. Edited by L. R. DeRouen and L. Harold Stevenson.

Descriptors: *Ecosystem analysis, *Environmental impact, *Urbanization, *Calcasieu River, *Calcasieu Lake, *Estuaries, *Louisiana, Ecosystems, Water quality, Chemical analysis, Benthic environment, Zooplankton, Hydrologic studies.

The Calcasieu River/Lake Complex is an important resource in southwestern Louisiana. The watershed of the system has been developed by municipal, industrial, and agricultural interests, and the waterways are used for waste discharge, transportation, recreation, and commercial fisheries. Because of the multiple uses of the system, there is a potential for degradation of the estuary. This document reports on research undertaken in an effort to understand the basic ecology of the Calcasieu River/Lake Complex and to evaluate the effects of human activities on that ecology. Part of the work involved surveying the Calcasieu Estuary for the presence of anthropogenic substances as well as analyses of the effects of human activities on the biotic communities within the estuary. The field sampling and monitoring were conducted from October 1983 through August 1986. Routine sampling locations were sited throughout the estuary from the salt water barrier on the Calcasieu River north of Interstate 10 to the mouth of the system at Cameron. The impacts of land use on the estuary were investigated through seven major substudies: Water Quality and Special Pollutants; Chemistry; Primary Producers; Zooplankton; Benthos; Nekton; and Hydrology. The findings of each substudy are presented in separate chapters (1 through 7). In turn, most chapters are divided into subsections or segments, each of which represents a discrete, independent project within the scope of the total program. (See W89-05530 thru W89-05541) (Lantz-PTT)
W89-05529

OIL SHALE, WATER RESOURCES, VALUABLE MINERALS OF THE PICEANCE BASIN, COLORADO: THE CHALLENGE AND CHOICES OF DEVELOPMENT,
Geological Survey, Lakewood, CO. Water Resources Div.
O. J. Taylor.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Professional Paper 1310, 1987. 143 p, 90 fig, 5 tab.

Descriptors: *Oil shale, *Colorado, *Mining, *Water quality, Minerals, Water resources, Air pollution.

The Piceance basin of northeast Colorado contains about 1,200 billion barrels of shale oil and about 50 billion tons of nahcolite and dawsonite. The minerals originated in an ancient lake and are associated with ground water that occurs mostly in fractures. Mineral development will disrupt natural conditions in the basin because of the required mine drainage, mining, retorting, water development, mineral transportation, and reclamation. Proper development of the mineral resources will require additional investigations, carefully designed field procedures, and controll technology to avoid deleterious effects on the water resources and land surface of the basin and on the regional air quality. However, the potential benefits from mineral development are numerous and diverse. (USGS)
W89-05776

4D. Watershed Protection

STABILITY DESIGN OF GRASS-LINED OPEN CHANNELS,
Agricultural Research Service, Stillwater, OK. Plant Science and Water Conservation Lab.
D. M. Temple, K. M. Robinson, R. M. Ahring, and A. G. Davis.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-116629. Price codes: A06 in paper copy, A01 in microfiche. Agriculture Handbook Number 667, September 1987. 167p, 68 fig, 10 tab,a 54 ref, 2 append.

Descriptors: *Grassed waterways, *Erosion control, *Open channels, *Hydraulic structures, *Hydraulic properties, Agriculture, Hydraulic design, Channel flow, Mathematical studies.

This handbook presents the state of the art in grass-lined channel design. It is intended primarily for use by engineers and technicians directly involved in planning, designing, or maintaining open channels where vegetation can be used as a lining for erosion protection. Each of the six chapters (development of design relations; species selection, establishment, and maintenance of grass-lined channels; determination of channel design parameters; grass-lined channel design; calculator- or computer-assisted design; and graphical design of open channels) is a complete discussion, with reference to other chapters as appropriate. Nomographs and calculator/computer programs are included as design aids. Only those design conditions that have implications unique to the use of grass as a channel lining are discussed in detail, and the design aids focus on stability design under steady, uniform flow conditions. (Author's abstract)
W89-04849

URBAN GROWTH MANAGEMENT AND GROUNDWATER PROTECTION: AUSTIN, TEXAS.
Lower Colorado River Authority, Austin, TX. Dept. of Natural Resource Policy and Programs.
For primary bibliographic entry see Field 5G.
W89-05609

5. WATER QUALITY MANAGEMENT AND PROTECTION

5A. Identification Of Pollutants

PHYSICAL AND CHEMICAL CHARACTERISTICS OF WATER IN COAL-MINE PONDS, EASTERN OKLAHOMA, JUNE TO NOVEMBER 1977-81,
Geological Survey, Oklahoma City, OK. Water Resources Div.
L. J. Slack, and S. P. Blumer.
Oklahoma Geological Survey Special Publication 87-2, 1987. 116p, 159 fig, 6 tab, 67 ref.

Descriptors: *Chemical analysis, *Coal mines, *Physical properties, *Water analysis, *Pollutant identification, *Mine drainage, Oklahoma, Hydrogen ion concentration, Dissolved oxygen, Sulfates, Chloride, Iron, Manganese, Temperature, Specific conductivity.

Water at 102 sites in 59 coal-mine ponds in eastern Oklahoma was sampled at least twice during June to November 1977-81 to determine temperature, specific conductance, dissolved oxygen, pH, and dissolved sulfate, chloride, iron, and manganese - as part of a study of the hydrology of the Oklahoma coalfield. These determinations show that during June to October water in ponds deeper than 10 ft was stratified; ponds which had little or no change of temperature with depth generally were shallow or were sampled in early November. Temperature, dissolved oxygen, and pH usually decreased with depth, whereas specific conductance usually increased with depth. Concentrations of dissolved sulfate, chloride, iron, and manganese varied from site to site. Specific conductance, which is a measure of dissolved solids in the water, ranged from 93 to 4,800 micromhos/cm at 25 C. Some physical and chemical characteristics of the mine-pond water are related to the coal bed adjacent to the pond. Mean specific-conductance values and dissolved sulfate concentrations were greatest in ponds associated with mining of the Dawson, Weir-Pittsburg, and Secor coals. Mean dissolved iron concentrations were greatest in ponds associated with mining of the Dawson, Secor, and Hartshorne coals. Mean dissolved-manganese concentrations were greatest in ponds associated with mining of the Dawson, Weir-Pittsburg, and Secor coals, but greatly exceeded secondary drinking-water limits regardless of coal bed mined. (Author's abstract)
W89-04647

ACIDITY OF RAIN IN PUERTO RICO,
Puerto Rico Univ., Mayaguez.
For primary bibliographic entry see Field 2B.
W89-04675

CONTAMINANT QUANTIFICATION IN HYDROGEOLOGICAL INVESTIGATIONS,
Union Carbide Corp., South Charleston, WV.
B. E. Smith, L. A. Rivera Figueroa, and M. Alsopa.
IN: Third Caribbean Islands Water Resources Congress. Proceedings of a Symposium held in St. Thomas, U.S. Virgin Islands, July 22-25, 1986. p 79-82, 1 tab.

Descriptors: *Groundwater quality, *Quantitative analysis, *Pollutant identification, *Chemical analysis, Water sampling, Gas chromatography, Monitoring, Organic vapor analysis.

As part of a groundwater investigation to identify the occurrence of contaminants, consideration should be given to the development of a contaminant quantification method(s). The method(s) should be developed by considering the type of suspected contaminants, any easily identifiable constituents within the contaminants, methods to analyze for the contaminants, and coordination of the method(s) with the drilling and sampling program. Criteria for a quantification method(s) should include a comparable level of accuracy and precision with the investigation program, specific detection of key constituents, rapid turn-around time for analysis, reasonable costs, and documented analytical procedures. A study which utilized contaminant quantification methods on about 500 soil samples from 17 borings successfully identified the occurrence of contaminants beneath a waste disposal site. The results of the methods were used to prepare a Ground Water Quality Assessment of the site to satisfy RCRA regulations. Three contaminant quantification methods were employed: visual inspection, gas chromatography, and organic vapor analyzer (OVA). The results of these methods were compared with each other and with results from groundwater quality analyses. The gas

chromatography method proved to be the most effective and reliable, and correlated well with visual inspection. The OVA analysis did not correlate well and in the absence of the other two methods could have led to erroneous conclusions concerning the presence of contaminants. Although the OVA instrument is commonly used in contaminant identification studies, the results of these studies could be questionable. (See also W89-04665) (Lantz-PTT)
W89-04679

FIRST RADIOCESIUM PROFILE AND SNOW COVER MASS MEASUREMENTS,
National Board of Waters, Helsinki (Finland). Hydrological Office.
S. S. H. Kasi.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu, Finland, 6-8 June 1988. Vol. 2. The Academy of Finland, Helsinki, Finland. 1988. p 101-105, 3 fig, 6 ref.

Descriptors: *Radiochemical analysis, Chernobyl, *Cesium radioisotopes, *Snow cover, *Swamps, *Peat bogs, Gamma radiation, Hydrological data collections, Hydrologic models, Model studies, Nuclear powerplants, Wetlands.

The profile of cesium-137 in soil can be gauged nondestructively using a scintillation detector set in tubing or a hole in the soil (peat soils included) at different depths from the surface. Radiocesium fallout from the Chernobyl nuclear powerplant makes almost a plane at the surface of any soil. A scintillator or semiconduction detector can be set above the snow cover and the snow attenuation of cesium gamma radiation can be measured. This method is very sensitive to the snow cover mass thickness, i.e., to its water equivalent. The results of the first measurements and evaluations are presented. In relatively large regions in some decades the cesium method is more sensitive than its traditional counterparts for radioactive snow cover measurement which rely on the radiation of potassium-40. The very thick snow covers may attenuate readings using potassium-40 radioactivity. The cesium-137 layer is also present at the surface of any swamp. (See also W89-04731) (Author's abstract)
W89-04744

ROLE OF ACUTE TOXICITY BIOASSAYS IN THE REMEDIAL ACTION PROCESS AT HAZARDOUS WASTE SITES,
Battelle Pacific Northwest Labs., Richland, WA.
L. A. Athey, J. M. Thomas, J. R. Skalski, and W. E. Miller.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-125430. Price codes: A06 in paper copy, A01 in microfiche. Report No. EPA/600/8-87/044, August 1987. 106p, 21 fig, 11 tab, 33 ref. Contract DE-AC06-76RL01830.

Descriptors: *Bioassay, *Industrial wastes, *Hazardous materials, *Waste dumps, *Cleanup, *Acute toxicity bioassay, Toxicity, On-site investigations, Soil analysis, Sediment analysis, Water analysis, Phytotoxicity.

The use of standardized aquatic and terrestrial acute toxicity bioassessment procedures and their use at four different sites is discussed. Soils from the Rocky Mountain Arsenal were bioassayed and the results were used to prepare a cleanup map based on phytotoxicity. Bioassay results from sediment samples taken from a wood treatment site in Mississippi, which ceased operation in 1979 were compared to chemical analysis results and demonstrated that bioassays can be used effectively to guide remedial actions at creosote-contaminated sites. Bioassay results from soil, sediment, and surface-water samples at two hazardous chemical waste sites in New Jersey were used to evaluate site toxicity, determine sources of chemicals, and illustrate the use of staged sampling and compositing. Bioassessment procedures have two important advantages over chemical analyses: (1) they can directly measure the effects of a known or suspected contaminant on plants and animals, and (2) they are inexpensive compared to complete chemical analyses. (White-Reimer-PTT)
W89-04747

TOXICITY REDUCTION EVALUATIONS IN MUNICIPAL WASTEWATER TREATMENT PLANTS,
Environmental Protection Agency, Cincinnati, OH. Water Engineering Research Lab.
D. F. Bishop.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-125703. Price codes: A03 in paper copy, A01 in paper copy, A01 in microfiche. Report No. EPA/600/D-87/320, October 1987. 27p, 6 fig, 10 tab, 16 ref.

Descriptors: *Bioassays, *Wastewater analysis, *Municipal wastewater, *Toxicity, Toxicity Reduction Evaluation, Ames mutagenicity, Water pollution control.

The evolving management method (Toxicity Reduction Evaluation) involves four major elements: (1) evaluating the causes of toxic substances passing through treatment plants, (2) characterizing and identifying the components of toxicity, (3) tracing substances to their sources, and (4) evaluating treatment alternatives for controlling toxic substances. Using the Toxicity Reduction Evaluation method, wastewaters from six municipal wastewater treatment plants were tested at different stages of treatment using static renewal seven-day acute-chronic Fathead minnow and Ceriodaphnia assays for assessing ecosystem effects, the Ames test and mammalian cell assay cells for mutagenicity screening, and the Sister Chromatid Exchange assay using Chinese hamster ovary cells for genotoxicity. Results indicate these methods provide affordable monitors for tracking ecosystem toxicity, providing characterization of the toxicity, and insight into the treatability of municipal wastewater. In addition, toxicity reduction surveys using health effects bioassays, such as Ames tests, reveal substantive bioassay responses in wastewaters entering and passing through selected municipal treatment plants. (White-Reimer-PTT)
W89-04748

ALLOWABLE RESIDUAL CONTAMINATION LEVELS OF RADIONUCLIDES IN SOIL FROM PATHWAY ANALYSIS,
Oak Ridge National Lab., TN. Environmental Sciences Div.
J. E. Nyquist.
Available from the National Technical Information Service, Springfield, VA 22161, as DE88-001762. Price codes: A03 in paper copy, A01 in microfiche. 1987. 14p, 2 fig, 3 tab, 18 ref. Contract DE-AC05-840R21400.

Descriptors: *Water pollution sources, *Model studies, *Computer models, *Soil management, *Soil contamination, *Groundwater pollution, Radionuclides, Oak Ridge National Laboratory, Path of pollutants.

The DECOM computer code, which estimates concentrations of radionuclides uniformly distributed in soil that correspond to an annual effective dose equivalent, is written in BASIC and runs on an IBM PC or compatible microcomputer. With modifications it provides a flexible approach capable of handling different levels of contamination, dose limits, and closure scenarios for radionuclide distributions among Remedial Action Program sites. Both the spreadsheet and BASIC versions of DECOM provide an easy-to-use dose assessment model; however, dose assessment models are limited by the data used, and many of the parameters built into the model are approximations, mathematical measures of central tendency of a distribution of measured values (often derived from different sources, each more or less representative of the parameter as defined by the model), or best guesses. The user should examine the effect of varying parameter values on the results, and to replace default values with site-specific measurements. (White-Reimer-PTT)
W89-04754

METALS IN COASTAL ENVIRONMENTS OF LATIN AMERICA,
Springer-Verlag, New York. 1988. 297p. Edited by U. Seeliger, L.D. de Lacerda and S.R. Patchineelam.

Descriptors: *Metals, *Metal complexes, *Heavy metals, Monitoring, Runoff, Symposium, Conference, Latin America, Coastal waters.

An International Symposium on Metals in Coastal Environments of Latin America was held in August 1986, in Brazil. The vast land mass of the Latin American continent contributes via natural runoff to the balance of metals in the Southwestern Atlantic and Southeastern Pacific oceans. During the last two decades some of this continent's countries have witnessed a rapid and often chaotic demographic and industrial growth leading to substantial problems of decreasing environmental quality and increasing metal fluxes to the adjacent oceans. The symposium gathered information on the state of present metal pollution research in Latin America, to introduce modern research approaches, to trace policies for a rational management of the continent's coastal environment and to bring these findings to the attention of a Latin American and international forum. (See also W89-04756 thru W89-04781) (White-Reimer-PTT)
W89-04755

HEAVY METALS SURVEYS IN BRAZILIAN COASTAL ENVIRONMENTS,
Universidade Federal do Rio de Janeiro (Brazil). Inst. de Biofisica.
W. C. Pfeiffer, M. Fiszman, and L. C. Lacerda.
IN: Metals in Coastal Environments of Latin America. Springer-Verlag, New York. 1988. p 3-8, 1 fig, 2 tab, 18 ref.

Descriptors: *Path of pollutants, *Metals, *Heavy metals, *Monitoring, *Brazil, Surveys, Latin America, Coastal waters, Urban areas, Copper, Zinc, Industrial wastes.

The Brazilian coast presents a great diversity of landforms and habitats, including almost all types of coastal ecosystems, from equatorial to temperate regions. The coastline can be roughly divided into four major units with specific characteristics which affect the fate of heavy metals in each area. In the north of Brazil no evidence exists on contamination of coastal areas by trace metals, although close to big cities moderate levels of urban waste derived metals (such as Cu and Zn) may be expected. Further south a few cases of serious contamination are documented, in particular in the Todos os Santos Bay, Bahia, where high concentrations of oil, chemical and metallurgic industries have developed in the last two decades. Elevated metal levels in many marine organisms indicate that a significant biologically available fraction of the total metal content exist in all of the areas. The existing data are generally the result of local surveys, although recently methods to monitor metal contamination on a regional scale have been proposed. (See also W89-04755) (White-Reimer-PTT)
W89-04756

HEAVY METALS IN WATER AND SEDIMENTS OF THE BLANCA BAY, ARGENTINA,
Instituto Argentino de Oceanografia, Buenos Aires.
For primary bibliographic entry see Field 5B.
W89-04757

PRELIMINARY SURVEY OF HEAVY METAL CONCENTRATIONS IN SOME ESTUARINE ORGANISMS IN THE LITTORAL ZONE OF SAO LUIS ISLAND, MARANHAO, BRAZIL,
Universidade Federal do Maranhao, Sao Luis (Brazil). Lab. de Hidrobiologia.
For primary bibliographic entry see Field 5B.
W89-04758

STUDY OF HEAVY METAL POLLUTION IN THE TRIBUTARY RIVERS OF THE JACARE-

PAGUA LAGOON, RIO DE JANEIRO STATE, BRAZIL, THROUGH SEDIMENT ANALYSIS,
Comissao Nacional de Energia Nuclear de Brasil, Rio de Janeiro. Inst. de Radioproteccao e Dosimetria.
H. L. Azevedo, H. R. Monken, and V. P. Meto.
IN: Metals in Coastal Environments of Latin America. Springer-Verlag, New York. 1988. p 22-29, 1 fig, 3 tab, 5 ref.

Descriptors: *Chemicals analysis, *Water pollution sources, *Metals, *Heavy metals, *Sediments, Bottom sediments, Monitoring, Cadmium, Lead, Copper, Zinc, Chromium, Nickel, Cobalt, Manganese, Iron, Jacarepagua Lagoon, Brazil, Path of pollutants, Industrial wastewater, Domestic wastes.

Bottom sediment samples were collected along the rivers and analyzed for Cd, Pb, Cu, Zn, Cr, Ni, Co, Mn, and Fe using flame atomic absorption spectrometry. Rio Grande sediments showed the highest background concentrations of Cr, Ni, Cu, Zn and high concentration of Cd and Pb. One of the background samples from Rio do Anil showed the highest concentration of Pb which may be related to the proximity of the sampling station to an urban highway and also to the road network in the drainage area. The impact of industrial activities on the heavy metal concentration in river sediments of this area is evident. Arroio Pavuna is the principal source of Cd, Ni, Cu and Cr for the aquatic ecosystem of the lagoon although Rio do Anil is also a significant source of Cr and Cu. All of the rivers studied are potential sources of Zn due to domestic and industrial sewage. (See also W89-04755) (White-Reimer-PTT)
W89-04759

SPATIAL DISTRIBUTION OF HEAVY METALS IN SEAWATER AND SEDIMENTS FROM COASTAL AREAS OF THE SOUTHEASTERN BUENOS AIRES PROVINCE, ARGENTINA,
Instituto Argentino de Oceanografia, Buenos Aires. Lab. de Quimica Marina.
N. Villa.
IN: Metals in Coastal Environments of Latin America. Springer-Verlag, New York. 1988. p 30-44, 1 fig, 5 tab, 55 ref.

Descriptors: *Chemical analysis, *Coastal waters, *Water pollution sources, *Metals, *Heavy metals, *Sediments, Monitoring, Seawater, Copper, Cadmium, Zinc, Lead, Iron, Manganese, Buenos Aires Province, Argentina.

Four areas in Blanca Bay, Argentina, not associated with anthropogenic activities (Bermeja Channel, Enbudo Channel, Falsa Bay, and Verde Bay) were studied to establish the levels and ranges of Cu, Cd, Zn, Pb, Fe, Mn and other physico-chemical parameters in water and sediments. The highest concentrations of metals in seawater were found in the inner portions of the four areas sampled and levels decreased towards the more external sampling points. Differences between acid digested and undigested filtered seawater samples demonstrated that part of the dissolved metals was closely associated with dissolved organic matter. The levels of heavy metals in sediments were essentially the same in the four areas studied, except for nitric acid extracted manganese, which suggests a common origin. Metal concentrations determined by EDTA extraction correlated strongly with nitric acid extraction, indicating that metal extractability was largely dependent upon total concentration. The total metal content was negatively correlated with salinity which might indicate a continental origin of the metals. (See also W89-04755) (White-Reimer-PTT)
W89-04760

GEOCHEMICAL AND STATISTICAL APPROACH FOR ASSESSING METAL POLLUTION IN COASTAL SEDIMENTS,
Florida State Dept. of Environmental Regulation, Tallahassee.
J. D. Ryan, and H. L. Windom.
IN: Metals in Coastal Environments of Latin America. Springer-Verlag, New York. 1988. p 47-58, 5 fig, 15 ref.

Descriptors: *Chemical analysis, *Water pollution sources, *Cleanup, *Florida, *Metals, *Heavy metals, *Geochemistry, *Sediments, Coastal sediments, Statistical analysis, Aluminum, Estuaries, Miami River, Biscayne Bay, Remedial action.

To address the problem of distingishing anthropogenic metal sources from natural metal sources sediments were sampled in 13 bays and estuaries with different sediment types and geological origins. From these data, mean metal concentrations were determined and an assessment tool was developed and tested, using aluminum as a normalizing factor for identifying and comparing metal enrichment patterns along Florida's coastline. Metal concentrations from different sediment types within and between coastal systems were compared and ranked according to specific metal problems, and from this it was possible to focus on one priority problem area in Florida, the Miami River. From this critical information it is possible to make scientifically valid environmental and cost-effective decisions regarding cleanup, abatement and other remedial strategies, e.g. retrofitting several major stormwater discharges and identifying problem area in the river and bay that required dredging contaminated sediments. (See also W89-04755) (White-Reimer-PTT)
W89-04761

TRACE METAL DISTRIBUTION IN SEDIMENTS OF THE PATOS LAGOON ESTUARY, BRAZIL,
Fundacao Univ., Rio Grande (Brazil).
P. R. N. Baisch, L. F. H. Niencheski, and L. D. Lacerda.
IN: Metals in Coastal Environments of Latin America. Springer-Verlag, New York. 1988. p 59-64, 3 fig, 1 tab, 8 ref. CNPq grant 4000229/83.

Descriptors: *Path of pollutants, *Pollutants identification, *Water pollution sources, *Brazil, *Metals, *Heavy metals, *Sediments, *Geochemistry, Cadmium, Lead, Zinc, Chromium, Copper, Geochemical partitioning, Estuaries, Patos Lagoon Estuary, Industrial wastewater, Municipal wastewater, Atomic absorption spectroscopy.

Sediments were collected at 61 stations throughout the estuarine area in order to survey heavy metal contamination levels in the sediments and examine the geochemical partitioning of metals in areas influenced by anthropogenic inputs. Two distinct distribution patterns of metal concentrations can be detected. One pattern shows that the highest values of Cd and Cr occur along the industrial and harbour areas, the other indicates that Zn, Cu and Pb originate from both industrial and urban sewage sources. Results of the geochemical partitioning explain the restricted distribution of the highly contaminated areas since the residual and the reducible fractions under oxidizing conditions would make metal remobilization and transport in the sediment more difficult. (See also W89-04755) (White-Reimer-PTT)
W89-04762

ATMOSPHERIC LEAD DEPOSITION INTO GUARAPINA LAGOON, RIO DE JANEIRO STATE, BRAZIL,
Universidade Federal Fluminense, Niteroi (Brazil). Dept. de Geoquimica.
S. R. Patchineelam, C. M. Leitao Filho, K. Kristotakis, and H. J. Tobschall.
IN: Metals in Coastal Environments of Latin America. Springer-Verlag, New York. 1988. p 65-76, 5 fig, 2 tab, 24 ref.

Descriptors: *Water pollution sources, *Chemical analysis, *Metals, *Heavy metals, *Sediments, *Brazil, *Lead, Estuaries, Statistical analysis, Guarapina Lagoon, Rio de Janeiro State, Carbonates, Precipitation.

Six sediment core sampling sites were selected in Guarapino Lagoon, Brazil and samples collected, homogenized and separated into various aliquots for mineralogical composition, carbonate determination and heavy metal analyses. The predominant sediment is organic rich clay, with sand and sandy silt layers in some areas. A 'metal enrichment factor' was calculated by dividing the metal/aluminum ratio of the surface sediments with maximum metal accumulation, by the same ratio from the lower part, considered as 'background' for that core profile. This calculation yielded a maximum enrichment factor of 5 in the middle of the lagoon and values between 2 to 3 in the remaining cores. Factors governing the distribution and correlations between metals were examined using linear regression analysis and the bonding index. The results of the study indicate lead, with its origin from automobile emissions, enters the lagoon through atmospheric precipitation. (See also W89-04755) (White-Reimer-PTT)
W89-04763

METAL ION CONCENTRATION IN SEDIMENTS FROM HELLSHIRE, A JAMAICAN COASTAL ENVIRONMENT,
University of the West Indies, Kingston (Jamaica). Dept. of Chemistry.
For primary bibliographic entry see Field 5B.
W89-04764

GEOCHEMICAL DISTRIBUTION OF CD, CU, CR AND PB IN SEDIMENTS OF ESTUARINE AREAS ALONG THE SOUTHEASTERN BRAZILIAN COAST,
Universidade Federal Fluminense, Niteroi (Brazil). Dept. de Geoquimica.
For primary bibliographic entry see Field 5B.
W89-04765

BEHAVIOUR OF POLLUTANT METALS IN AQUATIC SEDIMENTS,
Universidade Federal Fluminense, Niteroi (Brazil). Dept. de Geoquimica.
J. E. L. Maddock, and C. E. A. Lopes.
IN: Metals in Coastal Environments of Latin America. Springer-Verlag, New York. 1988. p 100-105, 3 fig, 2 ref.

Descriptors: *Path of pollutants, *Brazil, *Fate of pollutants, *Metals, *Heavy metals, *Sediments, *Coastal waters, Copper, Absorption, Extraction techniques, Lagoa Vermelha.

Sediment cores were collected from Lagoa Vermelha, a small, shallow, hypersaline lagoon in Brazil. Material from each layer was treated separately. The sediment underwent the selective extraction procedure to determine what fractions of the absorbed copper were held to the sediment. A comparison between treated and untreated samples of sediment showed that copper was preferentially absorbed by organic material or precipitated as sulfide. Carbonates also absorbed a considerable amount of copper, but proportionally less than in the natural sediment. A high amount of absorbed copper was released by strong acid attack. Assuming that sediments will never be subject to very acid conditions, the results indicate that between 40% and 70% of absorbed copper should be readily releaseable into oxigenated water. (See also W89-04755) (White-Reimer-PTT)
W89-04766

TOTAL MERCURY LEVELS IN MARINE ORGANISMS OF THE BAHIA BLANCA ESTUARINE TROPHIC WEB,
Instituto Nacional de Investigacion y Desarrollo Pesquero, Mar del Plata (Argentina).
J. E. Marcovecchio, V. J. Moreno, and A. Perez.
IN: Metals in Coastal Environments of Latin America. Springer-Verlag, New York. 1988. p 122-129, 2 fig, 1 tab, 27 ref.

Descriptors: *Biological magnification, *Pollutant identification, *Metals, *Heavy metals, *Estuaries, *Argentina, *Mercury *Food chains, *Trophic level, Coastal waters, Mollusks, Crustaceans, Fish, Blanca Bay.

In 1983 and 1984, organisms that are typical of the Bahia Blanca area in Argentina were sampled monthly at seven stations, and mercury analyses

were carried out on one mollusk species, two crustacean species, and sixteen fish species. Results showed that biomagnification of total mercury occurs through the trophic chain in the Blanca Bay. Mercury levels increased with trophic levels, demonstrating concentration factors of 1.34, 1.64 and 3.18 between successive levels. Based on internationally accepted standards for human consumption twelve of the monitored species lacked individuals with mercury concentrations high enough for rejection, six species showed percentages that justify partial rejection, and all the individuals of one species were unsafe for human consumption. (See also W89-04755) (White-Reimer-PTT)
W89-04768

TOTAL MERCURY, CADMIUM AND LEAD DISTRIBUTION IN TISSUES OF THE SOUTHERN SEA LION (OTARIA FLAVESCENS) IN THE ECOSYSTEM OF MAR DEL PLATA, ARGENTINA,
Instituto Nacional de Investigacion y Desarrollo Pesquero, Mar del Plata (Argentina).
N. I. Pena, V. J. Moreno, J. E. Marcovecchio, and A. Perez.
IN: Metals in Coastal Environments of Latin America. Springer-Verlag, New York. 1988. p 140-146, 1 fig, 3 tab, 39 ref.

Descriptors: *Path of pollutants, *Metals, *Heavy metals, *Mercury, *Cadmium, *Lead, *Bioaccumulation, *Coastal waters, *Southern sea lion, Otaria flavescens, Mar del Plata, Argentina, Tissue analysis, Atomic absorption spectrophotometry, Flameless absorption spectrophotometry, Spectrophotometry.

Recently dead sea lions were collected from beaches and sea lion colonies, dissected, and analyzed using flameless absorption spectrophotometry for mercury and atomic absorption spectrophotometry with an air-acetylene flame for cadmium and lead. The highest mercury concentrations with mean values of 47 + or - 13 ppm were found in the liver. Lower levels were found in the kidney and muscle tissues. Lead concentrations were below the detection limit in the soft tissues. Lead concentrations in bone tissue showed a mean concentration of 1.6 + or - 0.02 ppm wet weight. Mean liver cadmium concentrations were 1.1 + or - 0.66 ppm wet weight, whereas the mean kidney concentration was 5.65 = or - 2.33ppm wet weight. (See also W89-04755) (White-Reimer-PTT)
W89-04770

LABORATORY EXPERIMENTS ON CO60 BIOACCUMULATION BY TROPICAL SEAWEEDS,
Universidade Federal do Rio de Janeiro (Brazil). Inst. de Biofisica.
A. C. S. Freitas, J. R. D. Guimaraes, V. A. Gouvea, and E. Penna-Franca.
IN: Metals in Coastal Environments of Latin America. Springer-Verlag, New York. 1988. p 147-154, 5 fig, 2 tab, 8 ref. Contract 3441.

Descriptors: *Bioindicators, *Path of pollutants, *Metals, *Heavy metals, *Cobalt, *Bioaccumulation, *Algae, Brazil, Seasonal variation, Salinity, Nuclear powerplants.

Whole thalli of three seaweed species were collected from sites near the Angra Nuclear Power plant, Brazil, processed and analyzed for cobalt-60 uptake and elimination. An equilibrium in Co60 uptake was reached in approximately 6 days for Sargassum sp. and 2 days for Galaxaura marginata with G. marginata exhibiting a higher bioaccumulation factor than Sargassum sp. Elimination followed a two-component exponential pattern in both species. However, Co60 appears to be less available for exchange in G. marginata. Bioaccumulation factors were higher under lower salinity conditions, and those specimens kept in the dark had higher bioaccumulation factors than those in the light. Possibly as a result of the relationship between Co accumulation and metabolism, a marked temporal variation was found in Co60 bioaccumulation factors of Sargassum sp. in a series of experiments with plants collected at different times of the year, with higher bioaccumulation factors in experiments performed with plants collected in summer. (See also W89-04755) (White-Reimer-PTT)
W89-04771

TECHNETIUM IN COASTAL ENVIRONMENTS: FIELD OBSERVATIONS AND LABORATORY EXPERIMENTS,
Centre d'Etude de l'Energie Nucleaire, Mol (Belgium). Dept. de Biologie.
For primary bibliographic entry see Field 5B.
W89-04775

METAL MONITORING IN COASTAL ENVIRONMENTS,
Uppsala Univ. (Sweden). Dept. of Hydrology.
L. Hakanson.
IN: Metals in Coastal Environments of Latin America. Springer-Verlag, New York. 1988. p 239-257, 9 fig, 6 tab, 34 ref.

Descriptors: *Metals, *Heavy metals, *Monitoring, *Coastal waters, *Sediments, Sweden, Bioavailability, Path of pollutants, Fate of pollutants.

A summary of Swedish results on the linkage between bottom dynamic conditions and assessment of heavy metals in coastal environments, with an emphasis on principles and processes of general validity rather than on specific geographical/ecological characteristics of a given coastal environment is presented. In order to define bottom dynamic conditions indirect methods and approximations, such as the in situ cone penetrometer, must be accepted. The degree of contamination for a defined coastal area/recipient and the contamination factor for a defined metal in a given recipient may be used to give a reasonable and standardized description of the sediment contamination. The approach presented is based upon certain sedimentological presuppositions and it may be improved by accounting for various fractions of metals, the fact that different metals have different affinities to various types of carrier particles and different partitioning coefficients, and the difference between total concentration and biologically active concentration. (See also W89-04755) (White-Reimer-PTT)
W89-04776

MULTISPECIES METAL MONITORING IN TROPICAL BRAZILIAN ESTUARIES,
Fundacao Univ., Rio Grande (Brazil). Dept. of Oceanography.
U. Seeliger, and M. Wallner.
IN: Metals in Coastal Environments of Latin America. Springer-Verlag, New York. p 258-269, 6 fig, 1 tab. 40 ref. Brazilian National Research Council grants 4029. 19/82 and 30.1593.81.

Descriptors: *Water pollution sources, *Bioindicators, *Metals, *Heavy metals, *Monitoring, *Estuaries, Algae, Copper, Lead, Zinc, Cadmium, Brazil, Atomic absorption spectrophotometry, Chemical analysis.

Several species of the green macroalga Enteromorpha were tested for species dependent sorption kinetics to assess their validity for field monitoring and secondly, to furnish a first comparative evaluation of dissolved ionic metal concentrations in tropical Brazilian environments. Field samples were collected over a period of one year from estuaries along the northeastern Brazilian coast and analyzed for Cu, Pb, Zn, and Cd with an atomic absorption spectrophotometer. The species independent accumulation of all four metals at all concentrations suggests similar cation exchange properties of the sulfated polysaccharides involved, and though their concentrations may vary between species, binding sites seem to be in excess of available metals in the culture medium. A variety of geo-physico-chemical estuarine processes act on the conservative and non-conservative behaviour of dissolved metals in these waters causing their differential concentrations between upper and lower estuaries. Average annual dissolved Cu, Pb, and Zn concentrations found in these estuaries exceed those considered natural background levels in temperate systems, and high sporadic average monthly concentrations might reflect an anthropogenic contribution of these metals to these estuaries. (See also W89-04755) (White-Reimer-PTT)
W89-04777

SELECTED BIVALVES FOR MONITORING OF HEAVY METAL CONTAMINATION IN THE COLOMBIAN CARIBBEAN,
Universidad Nacional de Colombia, Bogota.
N. Campos.
IN: Metals in Coastal Environments of Latin America. Springer-Verlag, New York. 1988. p 270-275, 1 fig, 2 tab, 19 ref. Contract 30003-1-50-83.

Descriptors: *Bioindicators, *Metals, *Heavy metals, *Caribbean, *Monitoring, *Estuaries, Mollusks, Bivalves, Cadmium, Copper, Lead, Colombia, Tissue analysis, Bioavailability.

Benthic bivalves were sampled along the Caribbean coast of Columbia, dried and pulverized, and analyzed for Cd, Cu, and Pb. The highest cadmium levels were found in Crassostrea rhizophorae and the lowest in Donax denticulatus. Copper values were highest in C. rhizophorae and lowest in Isognomon alatus and I. bicolor. Lead concentration varied between 0.42 ppm in I.alatus and 15.6 ppm in C. rhizophorae with exceptionally high concentrations found in I. bicolor in one location. Some bivalves have been shown to reflect metal concentrations in water, and fluctuations of tissue metal concentrations in the four species studied may reflect metal levels in the surrounding water and/or changes between metal species with different biological availabilities. Both Crassostrae rhizophorae and Isognomon alatus seem to be bivalves appropriate for metal monitoring studies in the Colombian Caribbean. (See also W89-04755) (White-Reimer-PTT)
W89-04778

EICHHORNIA CRASSIPES AS A BIOLOGICAL MONITOR OF HEAVY METALS IN SURFACE WATERS,
Universidade Federal Fluminense, Niteroi (Brazil). Dept. de Geoquimica.
J. E. Maddock, M. B. Santos, and R. S. Marinho.
IN: Metals in Coastal Environments of Latin America. Springer-Verlag, New York. 1988. p 276-285, 3 fig, 2 tab, 25 ref.

Descriptors: *Bioindicators, *Path of pollutants, *Metals, *Heavy metals, *Monitoring, Surface waters, Bioaccumulation, Aquatic plants, Cobalt, Nickel, Lead, Zinc, Rio de Janeiro, Brazil, Tidal effects, Industrial wastewater, River flow, Rainfall.

The absorption of cobalt by Eichhornia was measured in the laboratory to determine if this plant concentrated low concentrations quantitatively and could be used as a pre-concentrator in the analysis of contaminated water. Results suggest the plant cobalt content in natural waters indicates the 'availability' of cobalt in those waters and not its concentration, which may have been diminished previously by absorption. Plants collected from 14 rivers in the State of Rio de Janeiro were analyzed for Co, Ni, Pb, and Zn. The mean concentrations of metals in plant ashes varied greatly from one river to another and were generally much higher in plants from water courses which were known to receive industrial effluents. The lack of correlation between plant and water concentrations can possibly be explained by the variability of water metal concentrations over short periods due to variations in rainfall/river flow and tidal flows causing a single water sample to be nonrepresentative of the mean river water concentrations. (See also W89-04755) (White-Reimer-PTT)
W89-04779

STRATEGIES FOR BIOLOGICAL MONITORING: THE EUROPEAN EXPERIENCE,
King's Coll., London (England). Monitoring and Assessment Research Centre.
H. S. Morris, Y. Samiullah, and M. S. A. Burton.
IN: Metals in Coastal Environments of Latin America. Springer-Verlag, New York. 1988. p 286-292, 14 ref.

Descriptors: *Coastal waters, *Monitoring, *Bioindicators, *Pollutant identification, Europe, Marine environment, Baseline studies, International agreements, Regional planning.

Biological monitoring is an essential component in the assessment of marine pollution problems, and a growing awareness of marine pollution problems in Europe over the last two decades has led to increased international cooperation in monitoring programs. A comprehensive evaluation attempts to establish relationships between pollutant concentrations in water, sediments and organisms as well as determining resultant effects in biota. However, many subtle effects in organisms are difficult to monitor in the field and also difficult to equate with a specific pollutant. In spite of this, their particular value as inexpensive preliminary indicators of general adverse conditions which may be rapidly assessed on a regional scale should not be overlooked. As a result of international cooperation in Europe regional monitoring programs have acquired over a decade of experience in monitoring pollutant levels in organisms although complete comparability of the results of each network has not yet been achieved. Nevertheless the data base of concentrations and trends in marine pollutants is growing and the duplication of effort in some areas is being avoided. (See also W89-04755) (White-Reimer-PTT)
W89-04780

METALS IN COASTAL ENVIRONMENTS OF LATIN AMERICA: RECOMMENDATIONS FOR A CRITICAL SITUATION,
Fundacao Univ., Rio Grande (Brazil). Dept. of Oceanography.
U. Seeliger, and L. D. Lacerda.
IN: Metals in Coastal Environments of Latin America. Springer-Verlag, New York. 1988. p 295-297, 3 ref.

Descriptors: *Coastal waters, *Research priorities, *Metals, *Heavy metals, *Monitoring, *Latin America, Water pollution, International agreements, Water pollution sources, Pollutant identification, Surface waters.

Effective communication between researchers within and between countries is a key issue for coordinated and rapid progress of metal pollution studies in coastal environments in Latin America. Due to the present economic difficulties resulting in limited funding of research to solve growing environmental problems and few well equipped laboratories only large scale screening and monitoring of metals along the extensive coastline can be conducted initially. Metal inputs from major rivers are virtually unknown and might require multinational research projects to assess the continent's contribution of heavy metals. Effective communication between researchers within and between countries is a key issue for coordinated and rapid progress of metal pollution studies in these coastal environments. A variety of existing international agencies and organizations should be utilized to stimulate, coordinate, and advance metal pollution studies in the aquatic and terrestrial environment. (See also W89-04755) (White-Reimer-PTT)
W89-04781

ANALYTICAL TECHNIQUES AND RESIDUALS MANAGEMENT IN WATER POLLUTION CONTROL SPECIALTY CONFERENCE APRIL 19-20, 1988.
For primary bibliographic entry see Field 5G.
W89-04782

IMPORTANCE OF SMITH-HIEFTJE BACKGROUND CORRECTION IN GFAAS,
Thermo Jarrell Ash Corp., Franklin, MA.
G. R. DuLude, J. J. Sotera, and M. C. Almeida.
IN: Analytical Techniques and Residuals Management in Water Pollution Control Specialty Conference April 19-20, 1988. Water Pollution Control Federation, Alexandria, VA 22314-1994. p 1-4, 1 fig, 1 tab, 9 ref.

Descriptors: *Water analysis, *Atomic absorption spectroscopy, Smith-Hieftje background correction, Chemical interference, Errors, Arsenic, Aluminum, Performance evaluation.

Smith-Hieftje background correction is a single-source technique that measures and corrects background at the analytical wavelength of interest during graphite furnace atomic absorption spectroscopy (GFAAS). The technique is based on the current pulsing scheme of a single hollow cathode lamp. Essentially, the background contribution is measured at the high current pulse and subtracted from the total absorbance measured at the low current pulse, providing a background-corrected result. An experiment used to illustrate Smith-Hieftje background correction showed that the deuterium correction resulted in a substantial error in a sample in which simultaneous determination of arsenic in the presence of aluminum was attempted. The Smith-Hieftje background correction yielded a result differing by just 0.2 ppb from the certified arsenic content (EPA Performance Evaluation sample). The development of Smith-Hieftje background correction has helped to transform GFAAS from a research method to a routine analytical technique. The analyst need not be concerned with the possibility of structured background and the magnitude of background absorbance present during the atomization step is no longer critical. (See also W89-04782) (Rochester-PTT)
W89-04783

AUTOMATED DIRECT MEASUREMENTS OF TOTAL CYANIDE SPECIES AND THIOCYANATE IN PRESENCE OF EACH OTHER,
Metropolitan Sanitary District of Greater Chicago, IL.
N. P. Kelada.
IN: Analytical Techniques and Residuals Management in Water Pollution Control Specialty Conference April 19-20, 1988. Water Pollution Control Federation, Alexandria, VA 22314-1994. p 5-19, 3 fig, 4 tab, 2 ref.

Descriptors: *Cyanide, *Thiocyanate, *Chemical analysis, *Wastewater analysis, *Pollutant identification, *Colorimetry, Effluents, Automation, Water analysis, Regulations.

An automated system to distinguish between different cyanide species at the low levels found in municipal treatment plant effluents and other environmental samples was developed. Thiocyanate was also determined in the presence of other cyanide species. The colorimetric apparatus employed used thin film distillation, followed by UV irradiation, mixing, coils, and ultimately colorimetric determination with results recorded on a chart recorder. The three-channel system can analyze simultaneously for three parameters: acid-dissociable CN, total CN, and total CN + thiocyanate, at a rate of 20 samples/hr. In four treatment plant effluents studied, CN was substantially reduced between raw sewage and effluent, indicating that the plants were effective. Thiocyanate made up 15-81% of the CN in the samples. In industrial discharges from two chemical industries, a coking operation, and an oil refinery, CN was almost all thiocyanate. At a road salt dock, in contrast, nearly all the cyanide (26 mg/l) was in complex form and thiocyanate was entirely absent. Similarly thiocyanate was 0-7% of the CN in effluents at two plating companies. The present methodology is useful where thiocyanate should be excluded from the cyanide total for regulatory reasons. (See also W89-04782) (Rochester-PTT)
W89-04784

PRIORITY POLLUTANT TESTING APPROACH TO APPENDIX IX ANALYSIS,
Finnigan MAT, Frederick, MD.
J. A. Poppiti, and J. Daley.
IN: Analytical Techniques and Residuals Management in Water Pollution Control Specialty Conference April 19-20, 1988. Water Pollution Control Federation, Alexandria, VA 22314-1994. p 22-28, 4 tab.

Descriptors: *Priority pollutants, *Water analysis, *Pollutant identification, Gas chromatography, Mass spectroscopy, Pesticides, Dioxins, Polychlorinated biphenyls, Furans, Quality control, Target compound list.

An approach to EPA Appendix IX analysis consists of five parts: (1) gas chromatography/mass spectroscopy (GC/MS) of volatiles, (2) GC/MS of base/neutral/acids, (3) GC of pesticides and polychlorinated biphenyls, (4) GC/MS of chlorinated furans and dioxins, and (5) report consolidation and quality assurance/quality control (QA/QC) of all analytical results. Appendix IX analysis can be performed in any laboratory currently performing target compound list (TCL) type analyses. Successful implementation requires close cooperation of several groups within the laboratory operation, availability of adequate standards, and a good QA/QC program. Lists are given of volatile TCL Appendix IX compounds, volatile non-TCL Appendix IX compounds, base/neutral/acid Appendix IX compounds, and base/neutral/acid non-TCL Appendix IX. (See also W89-04782) (Rochester-PTT)
W89-04785

COMPARISON OF THE EP TOXICITY TEST TO THE TCLP,
Millipore Corp., Bedford, MA.
D. J. McCarthy.
IN: Analytical Techniques and Residuals Management in Water Pollution Control Specialty Conference April 19-20, 1988. Water Pollution Control Federation, Alexandria, VA 22314-1994. p 29-39, 4 tab, 13 ref.

Descriptors: *Chemical analysis, *Hazardous materials, *Wastewater analysis, Comparison studies, Performance evaluation, Dioxins, Organic solvents, Heavy metals, Pesticides, Herbicides, Gas chromatography, Mass spectroscopy, Filtration, Regulations, Toxicity Characteristic Leaching Procedure, *Extraction Procedure Toxicity Test, Atomic absorption spectroscopy.

The EPA published in 1980 its new Extraction Procedure Toxicity Test (EP Tox) for the evaluation of toxic hazardous waste; it focused on 14 contaminants consisting of heavy metals, pesticides, and herbicides. In 1986, the Toxicity Characteristic Leaching Procedure was implemented for evaluation of hazardous wastes for dioxins and spent organic solvents. The EP Tox Test and the TCLP consist of three basic steps: separation, agitation, and filtration, but there are distinct differences in how the two tests are performed. Analysis is conducted by atomic absorption, gas chromatography, or gas chromatography/mass spectrophotometry, depending on the nature of the contaminant. The differences between these two tests can be summarized (EP Tox vs. TCLP, respectively) as follows: contaminants covered, heavy metals, pesticides, herbicides vs. semivolatiles, volatile organics; equipment needed, 142-mm filter holder for heavy metals vs. 142-mm filter holder for semivolatiles and unspecified extractor vs. Zero Headspace Extractor; filter material, 0.45 micron membrane with prefilter vs. binderless glass fiber filter; filtration pressure, 75 psi maximum vs. 50 psi maximum; extraction fluid, 16X volume by weight with deionized water and pH 5 vs. 20X volume by weight of fluid chosen according to waste properties; agitation, not specified vs. end-over-end rotary agitation at 30 rpm; extraction time, 24 hr vs. 18 hr; and temperature, 20-40 C vs 22 C. In the future, the EP Tox test will be phased out as a means of classifying a waste as toxic, and it will be replaced by the TCLP. This will mean that eventually every toxic waste, regardless of the contaminant or the means of disposal, will be tested by TCLP. (See also W89-04782) (Rochester-PTT)
W89-04786

ANALYTICAL APPLICATION OF THE MICROTOX SYSTEM,
Microbics Corp., Carlsbad, CA.
A. Bullich.
IN: Analytical Techniques and Residuals Management in Water Pollution Control Specialty Conference April 19-20, 1988. Water Pollution Control Federation, Alexandria, VA 22314-1994. 5p.

Descriptors: *Microtox, *Bioassay, *Industrial wastes, *Toxic wastes, Drilling fluids, Sediment analysis, Wastewater analysis, Performance evaluation.

Environmental applications of the Microtox Acute Toxicity Test system are discussed, as follows: effluent monitoring, pre-treatment and industrial screening, toxicity reduction evaluations, sediment testing, hazardous waste remediation, and toxicity testing of drilling fluids. A recent laboratory round robin test found the Microtox Test to display average coefficient of variation of 17%. These data were generated using a standard protocol with four sets of five blind samples tested with two lots of reagent on eight separate test dates. Short-term toxicity tests will continue to be very valuable in solving and preventing environmental problems, but no single test will be useful for every situation. (See also W89-04782) (Rochester-PTT)
W89-04787

STATISTICAL QUALITY CONTROL FOR THE ANALYTICAL LABORATORY,
CompuChem Labs., Inc., Research Triangle Park, NC.
For primary bibliographic entry see Field 7B.
W89-04789

ROLE OF QUALITY ASSURANCE IN FUTURE EPA AUDITS,
Environmental Protection Agency, Athens, GA.
For primary bibliographic entry see Field 7A.
W89-04790

APPLICATION OF COMPUTERIZED QUALITY CONTROL CHARTS AND REPORTS FOR WASTEWATER FACILITIES,
Data Stream Systems, Greenville, SC.
For primary bibliographic entry see Field 5D.
W89-04791

BIOMONITORING AS A REGULATORY TOOL,
Environmental and Chemical Sciences, Inc., Aiken, SC.
K. E. Trapp, and G. W. Eidson.
IN: Analytical Techniques and Residuals Management in Water Pollution Control Specialty Conference April 19-20, 1988. Water Pollution Control Federation, Alexandria, VA 22314-1994. p 81-93, 5 fig, 18 ref.

Descriptors: *Toxicity, *Pollutant identification, *Monitoring, *Bioassay, Wastewater disposal, Municipal wastewater, Daphnia, Selenastrum, Fathead minnows, Regulations, Cost analysis, Acute toxicity tests, Chronic toxicity tests, Wastewater facilities.

State and federal regulatory agencies currently are focusing on the use of four species to assess the toxicity of effluents discharged into warm-water streams, rivers, and lakes by publicly-owned treatment works Daphnia pulex, Ceriodaphnia dubia (two cladocerans), Pimephales promelas (fathead minnow), and Selenastrum capricornutum (green alga). To provide a cost-effective approach to toxicity testing, most regulatory agencies follow a tiered approach. This procedure begins with short, inexpensive screening toxicity tests, followed by acute and chronic tests that provide definitive information regarding effluent toxicity. A regulatory agency may require that a discharge conduct chronic toxicity tests in addition to, or in place of, acute toxicity tests. Research has demonstrated that for Daphnia and Ceriodaphnia the concentration of dietary protein and that dietary protein affects test organism performance in chronic toxicity tests. To evaluate toxicity test data and determine the source of the toxicity, the aquatic toxicologist must be provided with information regarding the operation of a treatment facility. If repeated testing demonstrates that a facility is discharging a toxic effluent, procedures (such as toxicity identification evaluation (TIE) are designed to identify the toxic material. Design of a TIE program will be site-specific and care must be exercised to develop the most cost-effective approach. (See also W89-04782) (Rochester-PTT)
W89-04792

AQUATIC TOXICITY TESTING FOR HAZARDOUS MATERIALS,
Patapsco Wastewater Treatment Plant, Baltimore, MD.
J. V. Martin.
IN: Analytical Techniques and Residuals Management in Water Pollution Control Specialty Conference April 19-20, 1988. Water Pollution Control Federation, Alexandria, VA 22314-1994. p 94-109, 6 fig, 3 ref.

Descriptors: *Hazardous wastes, *Bioassay, *Wastewater disposal, *Municipal wastewater, *Industrial wastes *Toxicity, Microtox test, Fish, Shellfish, Crustaceans, Chemical oxygen demand, Pollutant identification, Acute toxicity tests, Chronic toxicity tests, Wastewater facilities.

Methods for measuring toxicity of influent and effluent waste streams at the Patapsco Wastewater Treatment Plant, Baltimore, are described. Bioassays for measuring toxicity, and a hybrid procedure for measuring the capacity of the plant's activated sludge to detoxify industrial wastes. The microbial bioassays used include the Microtox analysis, a respirometer-based toxicity procedure, and a substrate removal procedure (delta COD test). Other tests employed are the acute fish bioassay, a chronic animal bioassay, and a batch treatability procedure in which COD level is related to specific substrate utilization rate. Animals used in the animal bioassays include finfish, shellfish, and crustaceans. The bioassay remains one of the most compelling and convincing of analytical procedures for predicting the environmental consequences of industrial development and waste disposal activities. (See also W89-04782) (Rochester-PTT)
W89-04793

FUNDAMENTALS AND ANALYTICAL APPLICATIONS OF BIOLUMINESCENCE,
Georgia Univ., Athens. Dept. of Biochemistry.
For primary bibliographic entry see Field 7B.
W89-04794

WASTE TESTING AND QUALITY ASSURANCE.
American Society for Testing and Materials, Philadelphia, PA. Special Technical Publication 999. 1988. 173 p. Edited by David Friedman.

Descriptors: *Pollutant identification, *Quality control, *Sampling, *Testing procedures, *Environmental policy, *Environmental protection, *Testing procedures, Environmental quality, Groundwater pollution, Leaching, Federal jurisdiction, Administrative regulations, Evaluations, Hazardous materials, Chemical wastes, Chemical analysis.

This volume highlights the latest developments in the areas of waste and environmental media sampling, property and hazard testing, and chemical and biological analysis. The focus is on developments in the fields of leachability estimation, analytical method development and evaluation, and quality assurance. The papers emphasize testing methodology and quality assurance practices that are being developed or applied to implementing two pieces of Federal environmental legislation, the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) hazardous waste management programs. (See also W89-04817 thru W89-048) (Author's abstract)
W89-04816

DEVELOPMENT AND VALIDATION OF RCRA METHOD 8280 FOR DIOXINS AND FURANS,
Environmental Monitoring Systems Lab., Las Vegas, NV.
S. Billets, J. M. Ballard, T. L. Vonnahme, N. J. Nunn, and D. R. Youngman.
IN: Waste Testing and Quality Assurance. American Society for Testing and Materials, Philadelphia, PA. Special Technical Publication 999, 1988. p 1-13, 1 fig, 9 tab.

Descriptors: *Pollutant identification, *Chemical analysis, *Dioxins, *Chemical wastes, *Industrial wastes, *Environmental policy, *Environmental protection, *Testing procedures, Sampling, Polychlorinated biphenyls, Laboratories, Quantitative analysis, Soil contamination, Sludge.

RCRA Method 8280 for the analysis of chlorinated dibenzo-p-dioxins (CDD) and dibenzofurans (CDF), as published in the Federal Register in April 1983, revealed the need for several modifications to allow for the determination of the target analytes in complex matrices, such as industrial sludge and still-bottom samples. Details of these modifications and of the subsequent application of the revised method to a limited number of samples that were analyzed in the course of a multilaboratory evaluation are reported. Further evaluation of RCRA Method 8280 for the analysis of polychlorinated dibenzo-p-dioxins and dibenzofurans has been performed. The method has been modified to provide for the quantitation of total tetra- through octa-chlorinated dioxins and dibenzofurans and has been applied to sample matrices derived from industrial polychlorophenol sources as well as to fly-ash, still-bottom, and Missouri soil samples. As an additional test of method performance, an interlaboratory validation study was conducted in two parts. The first phase was intended to permit familiarization with the method by analyzing relatively simple matrices for a few specified analytes that had been spiked into the samples. The second phase required the total quantitation of tetra- through octa-CDDs and CDFs in complex samples containing the analytes at both low (ppt) and extremely high (ppm) levels; no spiking was used for these samples. A method detection limit study using all available 13C12-labeled PCDD and PCDF isomers spiked into seven different sample matrices was also performed, and the results indicated both matrix and homolog specific differences. New documentation of the revisions in method 8280 will include results from an interlaboratory study of the method and method detection limits of selected PCDDs and PCDFs in a variety of environmental and hazardous waste matrices. (See also W89-04816) (Author's abstract)
W89-04817

COLLABORATIVE STUDY OF THE TOXICITY CHARACTERISTIC LEACHING PROCEDURE (TCLP),
S-Cubed, La Jolla, CA.
W. B. Blackburn, I. Show, L. Williams, D. R. Taylor, and P. J. Marsden.
IN: Waste Testing and Quality Assurance. American Society for Testing and Materials, Philadelphia, PA. Special Technical Publication 999. 1988. p 14-61, 7 fig, 45 tab, 5 ref.

Descriptors: *Leaching, *Pollutant identification, *Testing procedures, Toxicity, *Hazardous materials, *Chemical analysis, *Landfills, *Pesticides, Environmental policy, Environmental protection, Organic compounds, Waste disposal, Laboratories, Volatility, Sampling.

The U.S. Environmental Protection Agency has developed a new procedure, the Toxicity Characteristic Leaching Procedure (TCLP), to more effectively simulate the leaching of hazardous materials from waste disposed in an unsecured landfill. The procedure involves (1) an 18-h extraction of a sample with sodium acetate solution and (2) the subsequent analysis of leachate for metals, pesticides, semivolatile organics, and volatile organic compounds. To validate the method for all but the volatile organic analytes, three waste samples at two different pH levels were sent to 23 different volunteer government and commercial laboratories for extraction and analysis. For validation of the TCLP procedure involving determination of volatile organic compounds, two fortified waste samples were distributed to each participating laboratory. The results and statistical analysis of this collaborative test indicate that the TCLP can be applied consistently by a diverse group of organi-

zations for the analyses considered in this study. (See also W89-04816) (Author's abstract)
W89-04818

HYDRIDE GENERATION METHODS FOR THE DETERMINATION OF ARSENIC, ANTIMONY, AND SELENIUM,
Accu-Labs Research, Inc., Wheatridge, CO.
S. J. Callio.
IN: Waste Testing and Quality Assurance. American Society for Testing and Materials, Philadelphia, PA. Special Technical Publication 999, 1988. p 62-66, 14 tab.

Descriptors: *Spectroscopy, *Pollutant identification, *Arsenic, *Antimony, *Selenium, *Chemical analysis, *Testing procedures, Quality control, Environmental protection, Environmental policy, Laboratories, Precision.

Although hydride generation methods have long been used for the analysis of As and Se by atomic absorption, very little work has been done on simultaneous hydride generation for the ICP (inductively coupled plasma) environment. An outline of the sample preparation and instrumental parameters for the determination of As, Sb, and Se by ICP/hydride is presented. Some quality assurance measurements that demonstrate the accuracy and precision of the method are briefly discussed. It is shown that the method can be used with Environmental Protection Agency Superfund Contract Lab Program (CLP)-type digestates and has great potential for producing reliable data for As, Sb, and Se in waste samples. (See also W89-04816) (Author's abstract)
W89-04819

METHODS FOR EVALUATING SOLIDIFIED WASTE,
Alberta Environmental Centre, Vegreville.
P. Hannak, A. J. Liem, and P. L. Cote.
IN: Waste Testing and Quality Assurance. American Society for Testing and Materials, Philadelphia, PA. Special Technical Publication 999, 1988. p 67-75, 5 fig, 1 tab, 6 ref.

Descriptors: *Testing procedures, *Pollutant identification, *Solid wastes, *Evaluations, *Path of pollutants, *Waste characteristics, *Physicochemical properties, Density, Specific gravity, Toxicity, Advection, Permeability coefficient, Leaching, Laboratories, Plumes.

A number of methods for characterizing solidified waste are currently being assessed in the EC/EPA/AEC/Industry Cooperative Study. These are short-term laboratory tests that yield information on material properties (bulk density, specific gravity, and moisture content), ability to maintain physical integrity (unconfined compressive strength and weathering resistance - freeze/thaw and wet/dry), potentials for release of contaminants by advective transport (permeability) and dissolution (acid neutralization capacity, Toxicity Characteristic Leaching Procedure - TCLP - and equilibrium leaching), indication of long-term rate of contaminant release (dynamic leaching), and containment mechanisms (sequential extraction). A method for quantifying resistance to wet/dry cycling was modified and tested on three samples consisting of (1) baghouse dust, water, cement, and soluble silicate; (2) lime, fly ash, and water; and (3) cement, bentonite, and water. The results indicate that the method is reproducible and can be used for process comparison; coating is a promising method for improving resistance to wet/dry cycling; and wet/dry and freeze/thaw tests may or may not produce similar results. (See also W89-04816) (Friedmann-PTT)
W89-04820

INTERLABORATORY EVALUATION OF ICP-AES METHOD 6010,
Environmental Monitoring Systems Lab., Las Vegas, NV.
T. A. Hinners, C. L. Jones, J. H. Biesiada, D. M. Schoengold, and T. H. Starks.
IN: Waste Testing and Quality Assurance. American Society for Testing and Materials, Philadelphia, PA. Special Technical Publication 999, 1988. p 76-80, 1 tab. U.S. EPA Contract 68-01-7159 and 68-01-7253.

Descriptors: *Quality control, *Evaluations, *Pollutant identification, *Environmental policy, *Environmental protections, *Spectroscopy, *Sludge, *Performance evaluation, *Testing procedures, Mine wastes, Soil contamination, Waste characteristics, Laboratories.

EPA Method 6010, inductively coupled plasma atomic emission spectroscopy (ICP-AES), is undergoing interlaboratory evaluation for sludge-type wastes. The wastes included in the study are furnace ash, treatment sludge, mine waste, electroplating sludge, and contaminated soil and sediments. Twenty-three elements will be determined by conventional ICP-AES in digests of the spiked and unspiked waste materials. The raw wastes as well as bulk digest will be analyzed by all participating laboratories so that the variation contributed by sample preparation can be distinguished from the variation contributed by the measurement process. Both sequential and simultaneous instruments will be used in the study to allow an assessment of performance as a function of instrument type. The study will include an analysis of variance to characterize the homogeneity of each waste material before distribution to the participating laboratories. Heterogeneous materials are not suitable for interlaboratory studies. Method 6010, Version 1, includes quality control tests to assess the data quality. If the results for diluted samples or for spiked digest are not within the control limit of + or - 10% specified for this study, the method of standard additions is required to provide data of acceptable quality. For this study, a four-point method of standard additions is specified to allow a least-squares analysis to obtain the sample concentrations. While Method 6010, Version 1, will accurately reflect the element quantities solubilized by the digestion procedure used, it will no reflect the waste content of an element when components in the waste form insoluble compounds (such as barium and lead with sulfate). However, the quality control spike addition in Method 6010, Version 1, will indicate a data-quality problem for affected elements in such a situation so that data of known quality are obtained. (See also W89-04816) (Author's abstract)
W89-04821

RCRA LABORATORY CERTIFICATION,
New Jersey Dept. of Environmental Protection, Trenton. Office of Quality Assurance.
For primary bibliographic entry see Field 6B.
W89-04822

COMPARATIVE STUDY OF PREPARATIVE AND ANALYTICAL TECHNIQUES FOR THE DETERMINATION OF SELENIUM IN WATER, SEDIMENT, AND VEGETATION MATRICES,
California Public Health Foundation, Berkeley.
M. S. Iskander, N. L. Yacoub, A. M. Holden, C. B. Smith, and R. D. Stephens.
IN: Waste Testing and Quality Assurance. American Society for Testing and Materials, Philadelphia, PA. Special Technical Publication 999, 1988. p 87-100, 7 fig, 8 tab, 7 ref.

Descriptors: *Comparison studies, *Pollutant identification, *Selenium, *Water analysis, *Chemical analysis, Spectroscopy, Sediment-water interfaces, Vegetation, Sediments, Sampling, Laboratories, Toxicity, Water pollution.

In an effort to evaluate the currently available methodologies for the determination of selenium (Se) (a potentially toxic and difficult-to-measure element) in various sample matrices, different approaches to sample preparation and analysis were considered. Modification of existing methods was applied when needed and modified methodologies were assessed. Nitric acid digestion, with and without hydrogen peroxide (H202) and hydrochloric acid (HCl), was considered. Total selenium in various digestates was determined by inductively coupled plasma-atomic emission spectroscopy (ICP-AES), heated graphite atomizer-atomic absorption (HGA-AA), and hydride generation-atomic absorption (HG-AA) spectrometry. The data generated by this work showed that there is a reasonable agreement between the Se results obtained by ICP-AES and HGA-AA in the sediment and vegetation samples. The HGA-AA technique, however, is preferred for the determination of low levels of Se in water (sub ppm) due to its higher sensitivity relative to that of ICP-AES. Several problems were encountered with the hydride generation technique (HG-AA), and its use required difficult manipulations and extreme care. Generally, Se recoveries of 77 to 108% were attained at levels of 2 and 30 ppm total Se. The various methods of sample preparation considered and the operating parameters of the different techniques used are described. (See also W89-04816) (Author's abstract)
W89-04823

QUALITY ASSURANCE ON THE GROUNDWATER MONITORING TASK FORCE FACILITY ASSESSMENT PROGRAM,
Life Systems, Inc., Cleveland, OH.
M. J. Kangas, T. E. Tyburski, J. A. Duchene, and P. H. Friedman.
IN: Waste Testing and Quality Assurance. American Society for Testing and Materials, Philadelphia, PA. Special Technical Publication 999, 1988. p 101-111, 3 fig, 7 tab, 5 ref.

Descriptors: *Superfund, *Quality control, *Groundwater pollution, *Environmental policy, *Administrative regulations, *Hazardous materials, *Pollutant identification, Laboratories, Sampling, Landfills, Leaching, Organic compounds, Evaluations, Project planning, Environmental protection.

The U.S. Environmental Protection Agency (USEPA) Hazardous Waste Groundwater Task Force (HWGWTF) is conducting, under its Facility Assessment Program, groundwater sampling at 58 sites where commercial land disposal facilities are located to determine whether or not these facilities are contaminating groundwater with hazardous wastes. Laboratory analyses of groundwater samples from these sites are being performed for organic compounds and metals, inorganic, and indicator parameters. An overview of initial quality assurance (QA) activities, applied to these analyses, is presented. A Data Evaluation Committee (DEC) consisting of HWGWTF members from USEPA headquarters, regional offices, and Office of Research and Development (ORD) laboratories provides QA overview for Facility Assessment Program activities. The DEC developed a Quality Assurance Project Plan (QAPP) specifically for the Facility Assessment Program (FAP). The QAPP established data quality objectives (DQO) that define the quality of the data desired from the groundwater sampling and analytical efforts. These DQO address data accuracy, precision, representativeness, completeness, and comparability. The QAPP also defines roles and responsibilities of HWGWTF members and contractors and procedures to be followed in achieving the DQO. An overview of QA activities performed by the HWGWTF DEC, and examples of improvements planned for subsequent QA efforts, based on experience gained during Phase I, are presented. The evaluation of analytical quality control (QC) data and laboratory performance through integration of information from performance evaluation samples, analytical chemistry audits, statistical summaries, and control charts for analytical data generated by Superfund Contract Laboratories, is described. (See also W89-04816) (Author's abstract)
W89-04824

ROUND-ROBIN STUDY OF LEACHING METHODS AS APPLIED TO SOLID WASTES FROM COAL FIRED POWER PLANTS,
Electric Power Research Inst., Palo Alto, CA.
I. P. Murarka.
IN: Waste Testing and Quality Assurance. American Society for Testing and Materials, Philadelphia, PA. Special Technical Publication 999, 1988. p 112-129, 8 tab, 3 ref.

Descriptors: *Testing procedures, *Environmental policy, *Environmental protection, *Administrative regulations, *Pollutant identification, *Waste characteristics, *Laboratories, Heavy metals, Sludge, Waste disposal, Chemical analysis.

In 1979, the Electric Power Research Institute (EPRI) sponsored a multiple laboratory investigation of the variability and reproducibility of the U.S. EPA extraction procedure (EP) used for classifying wastes. In late 1985 and early 1986, EPRI sponsored another round-robin study to compare the results of EPA's new toxicity characteristics leaching procedure (TCLP) with the EP. Three laboratories were used to extract and analyze the concentrations of 14 constituents (Ag, As, B, Ba, Cd, Cr, F, Hg, Mn, Pb, Se, SO4, V, and Zn) from seven utility wastes (three fly ashes, two bottom ashes, and two scrubber sludges). The results were evaluated to determine the reproducibility of the two methods, the factors contributing to the variability of the EP and TCLP extracts, and the differences in mean concentrations between the two extract types for the selected wastes. The results show that reproducibility differs by constituent, waste type, and between the two extraction methods. Generally, the concentration measured in the TCLP results (as measured by the coefficient of variation) are equal to or better than the EP results (for example, for As, B, Cd, Cr, Mn, and V). Differences in the extractions between laboratories accounted for at least 25% of the total variability more frequently for the EP than the TCLP. For the TCLP, the analytical variability components (that is, differences in the analyses between laboratories and differences in analyses of duplicate splits by the same laboratory) accounted for at least 25% of the total variability more frequently. (See also W89-04816) (Author's abstract)
W89-04825

METHODS FOR THE ANALYSIS OF ORGANOMETALLIC COMPOUNDS IN WASTES,
National Bureau of Standards, Gaithersburg, MD. Polymers Div.
G. J. Olson, F. E. Brinckman, and W. R. Blair.
IN: Waste Testing and Quality Assurance. American Society for Testing and Materials, Philadelphia, PA. Special Technical Publication, 999, 1988. p 130-145, 12 fig, 1 tab, 37 ref.

Descriptors: *Organometallic compounds, *Pollutant identification, *Chemical analysis, *Metal complexes, *Testing procedures, *Chromatography, *Methylmercury, *Methyltin, Laboratories, Chemical properties, Chemical wastes, Environmental protection, Environmental quality, Sampling, Trace levels, Organic compounds, Speciation.

Organometallic compounds occur in the environment as a result of anthropogenic and biogenic processes. Since organometals are often much more toxic than the corresponding inorganic forms of metals, it is important to be able to speciate the forms of metals in environmental samples at ultra-trace levels. Chemical speciation methods, based on the use of chromatographic separations followed by element-selective detection, are helping to measure organometal species e.g. methyltin and methylmercury, at their action levels (down to parts-per-trillion levels) in environmental matrices, leading to a better understanding of environmental occurrence, fate, effects, and transformation. New methods for nondestructive analysis of metal species on surfaces such as epifluorescence microscopy coupled with metal-selective fluorescent ligands) and microscopic spectroscopy techniques, are under development. (See also W89-04816) (Author's abstract)
W89-04826

DEVELOPMENT OF A PORTABLE TESTING PROCEDURE FOR MONITORING HALOGENATED SOLVENTS IN WASTE FUELS,
Auburn Univ., AL. Dept. of Chemical Engineering.
A. R. Tarrer, J. G. Perry, and W. M. Holloway.
IN: Waste Testing and Quality Assurance. American Society for Testing and Materials, Philadelphia, PA. Special Technical Publication 999, 1988. p 152-165, 7 fig, 4 tab, 9 ref.

Descriptors: *Pollutant identification, *Halogenated organic compounds, *Oil wastes, *Chemical analysis, *Flame photometry, Laboratories, Public health, Risks, Organic compounds, Halides, Oil, Oil refineries.

There has been recent concern as to the health risks involved in burning recycled oil containing halogenated compounds. Since about 500 million gallons of used oil are burned each year, an inexpensive and reliable test method is needed for determining the halogen content of a used oil at the site of its generator. In response to this need, Auburn University, under sponsorship of the EPA, has been working on the development of a field test to determine halogen concentrations in waste oils. This test is an extension of the Beilstein flame emission test and will selectively test for halogenated solvents in waste oils. The test is very inexpensive, easily performed, and agrees with the standard ASTM oxygen bomb technique within a margin of 10 to 25%. The test requires only hydrogen and copper wool as replenishable materials. A copper probe is first burned to remove any oxidation that may interfere with the test. The clean probe is then dipped into the oil sample and placed in the flame. Copper halides radiate light at about 436 nm; therefore, the presence of halogenated solvents is indicated by a blue-green emission. Halogen concentration is determined by measuring the flame intensity using a photocell. This test has shown great promise for on-site determinations of organic halide concentrations due to solvent contamination in waste oils. (See also W89-04816) (Author's abstract)
W89-04828

IMPROVED METHODS FOR HEPATITIS A VIRUS AND ROTAVIRUS CONCENTRATION AND DETECTION IN RECREATIONAL, RAW POTABLE, AND FINISHED WATERS,
Baylor Coll. of Medicine, Houston, TX.
J. L. Melnick.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-158944. Price codes: A04 in paper copy, A01 in microfiche. Report No. EPA/600/4-87/029, January 1988. 49p, 6 fig, 9 ref, append. Cooperative Agreement CR811258.

Descriptors: *Pollutant identification, *Viruses, *Recreational waters, *Raw water, Microbiological studies, Sampling, Biological studies, Suspended solids, Bioassay.

Procedures for the detection of hepatitis A virus and human rotavirus in surface and finished waters include the collection of samples, the processing of samples to concentrate and reconcentrate virus, and the assay of processed samples by tests that are appropriate for the detection of virus. Finished water samples may be collected from a distribution system outlet (faucet) or water main at a municipal water treatment plant. Recreational or raw potable water samples that may be collected include water, solids suspended in water, or the uppermost loose layer(s) of bottom sediments, called fluffy sediments. Water and suspended solids may be collected and processed as a single sample or collected and processed separately. Procedures for detecting rotavirus are based upon an infection-virus-dependent, indirect immunofluorescence test in cell culture, using a monoclonal antibody and fluorescein-isothiocyanate-conjugated antibody-staining method to visualize virus-infected cells. Procedures for detecting hepatitis A virus are based upon the use of labeled nucleic acid probes in hybridization tests to detect virus nucleic acid. (Lantz-PTT)
W89-04846

NATIONAL ACID PRECIPITATION ASSESSMENT PROGRAM,
H. Petrimouix.
IN: Acid Deposition in Maryland: The Status of Knowledge in 1987. Maryland Power Plant Research Program Report No. AD-88-1, January 1988. p 39-49, 1 fig, 2 tab, 3 ref.

Descriptors: *Acid rain, *Regulations, *Federal government, *Water pollution effects, *Water pollution sources, *Air pollution, Research priorities, Financing, Policy making.

The National Acid Precipitation Assessment Program (NAPAP) is approximately halfway through its 10-year authorization for sponsoring and conducting federal research into the causes and effects of acidic deposition. NAPAP is conducting or sponsoring research in two major areas - atmospheric processes (from emissions of pollutants, through chemical transformations in the air, to the transportation and deposition of acid compounds on the ground) and effects (impact of deposition on trees, lakes, etc). Much of NAPAP's funding between now and 1990 will be used to develop and validate an acidic deposition model that will predict long-range transport and deposition rates and provide data for making policy decisions. Although NAPAP is conducting research in a number of areas to reduce the scientific uncertainties associated with acidic deposition, it will not have definitive answers on key issues by 1990. According to NAPAP officials, the scientific complexities involved in understanding the atmospheric processes and effects of acidic deposition are so great that research will be needed beyond 1990. Among the important unknowns that will remain beyond 1990 are the effects of acidic deposition on forest ecosystems and many man-made materials. It is unclear whether NAPAP will be able to meet its goal of obtaining and analyzing research to be used as a basis for policy decisions by 1990. NAPAP recently issued its Interim Assessment, which summarizes the results and conclusions of the program's research at the mid-point of its 10-year investigation. Some of the major conclusions have been criticized as being inconsistent with the research results. Critical evaluations of these findings and their implications for Maryland will be provided in subsequent editions of this annual report. (See also W89-04861) (Lantz-PTT)
W89-04862

IMPROVED STREAMFLOW AND WATER QUALITY MONITORING USING A MICROPROCESSOR-BASED SYSTEM,
Forest Service, Ogden, UT. Intermountain Research Station.
For primary bibliographic entry see Field 7B.
W89-04876

INTEGRATED APPROACH TO A STUDY OF CONTAMINANTS AND TOXICITY IN MONROE HARBOR (RIVER RAISIN), MICHIGAN, A GREAT LAKES AREA OF CONCERN: SUMMARY REPORT.
Environmental Research Lab.-Duluth, Grosse Ile, MI. Large Lakes Research Station.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-126008. Price codes: A10 in paper copy, A01 in microfiche. Report No. EPA/600/3-87/044, November 1987. 182p, 50 fig, 22 tab, 72 ref, 2 append. EPA Grant 810232, 810775, 810776, 810808, 811578 and 811731. EPA Contract 68-01-7170.

Descriptors: *Pollutant identification, *Path of pollutants, *Water pollution effects, *Toxicity, *Michigan, Bioassay, Water quality, Bioaccumulation, Polychlorinated biphenyls, Copper, Zinc, Chromium, Heavy metals, Monroe Harbor, Great Lakes.

Chemical-specific and toxicity based approaches were used to assess effluent and receiving water quality of Monroe Harbor, Michigan. Toxicity was defined and measured by bioassay techniques using water both from control sites and points of impact. Inhibition of bacterial decomposer activity, phytoplankton productivity, zooplankton reproduction and grazing efficiency, survival of zooplankton and larval fish and contaminant accumulation were measured. An undetermined loading of PCBs approaching 200 g/day in the Lower Raisin River was found by using an input-output mass balance model. A probable local source of copper, zinc and chromium contamination is suggested by the finding of elevated levels of these metals in sediments. An attempt was made to integrate the toxicity based and chemical specific approaches. Zinc and

copper appear to be toxic to different species and to affect specific ecosystem functions, either singly or in combination. Although PCBs were important in the bioaccumulation studies, they did not appear significant in describing observed toxicity in the Ceriodaphnia reproduction and survival in the seven day Mount-Norberg life cycle test. (Author's abstract)
W89-04877

ACID/NEUTRAL CONTINUOUS LIQUID/LIQUID EXTRACTION OF PRIORITY POLLUTANTS AND HAZARDOUS SUBSTANCE LIST COMPOUNDS,
Environmental Protection Agency, Annapolis, MD. Central Regional Lab.
J. L. Slayton, and E. R. Trovato.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-157631. Price codes: A04 in paper copy, A01 in microfiche. Report No. EPA/903-9-88-001, January 1988. 65p, 14 fig, 20 tab, 10 ref.

Descriptors: *Pollutant identification, *Organic compounds, *Chemical analysis, *Wastewater analysis, Wastewater treatment, Water quality control, Pentachlorophenol, Nitrophenol, Phenols, Benzoic acid, Extraction.

Continuous liquid-liquid extraction was compared to manual extractions according to EPA Method 625, but employing an acid-neutral scheme. The results from EPA performance evaluation (quality control) wastewater, Superfund, and RCRA samples were compared using the two extraction techniques. Continuous liquid-liquid extractions following an acid-neutral scheme were compared to those following a base-neutral scheme. The acid-neutral continuous extraction scheme was determined to be effective and labor saving. Emulsion formation was reduced and the recoveries of phenol, 4-nintrophenol, pentachlorophenol and benzoic acid were significantly improved by using the continuous extractor. The acid-neutral scheme as opposed to the Method 625 base-neutral extraction was found to improve the recovery of dimethyl-, diethyl-, di-n-butyl-, and n-butyl benzyl phthalate esters. The levels of target and additional compounds extracted using a continuous extractor from the environmental samples tested equaled or exceeded those obtained from manually extracted samples. The distribution of target compounds in the acid-neutral and base fraction was determined by analyses of performance evaluation samples. All identifications and quantifications were performed using GC/MS systems with fused capillary columns. (Author's abstract)
W89-04879

GUIDELINES FOR MEASURING THE PHYSICAL, CHEMICAL, AND BIOLOGICAL CONDITION OF WILDERNESS ECOSYSTEMS,
Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.
For primary bibliographic entry see Field 7A.
W89-04881

CHARACTERIZATION OF PRODUCED WATERS FROM NATURAL GAS PRODUCTION OPERATIONS. EXECUTIVE SUMMARY,
ERT, Pittsburgh, PA.
D. Wesolowski, A. Broughton, C. A. Hansotte, S. M. Koraido, and J. P. Fillo.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-173109. Price codes: A03 in paper copy, A01 in microfiche. Report No. GRI-87/0335.3, December 1987. Topical Report (July 1986 - December 1987). 10 p, 1 tab. Gas Research Institute Contract 5084-253-1117.

Descriptors: *Pollutant identification, *Natural gas, *Environmental effects, Volatile organic compounds, Chlorides, Dissolved solids, Organic compounds.

Results of a nationwide program for the sampling and analysis of produced waters from natural gas production operations, are presented. The regulatory background, project objectives and scope, project description, and study design are reviewed briefly to provide a summary of the major technical elements of the work. The primary focus of this section is to present a synopsis of the major findings and conclusions from the study. The results indicate that the characteristics and volumes of produced waters are highly variable, site-specific, and dependent on the characteristics of the producing formation. In general, the produced waters sampled in this program contained volatile organics and, to a lesser degree, selected semivolatile organics. Selected minor and trace elements also were present in the produced water samples. Chloride and total dissolved solids were the most predominant conventional parameters detected. Produced waters did not generally exhibit current RCRA hazardous waste characteristics. The predominant method used to dispose of these waters is underground injection into Class II wells regulated under the Safe Drinking Water Act. (See W89-04887 thru W89-04888) (Lantz-PTT)
W89-04886

CHARACTERIZATION OF PRODUCED WATERS FROM NATURAL GAS PRODUCTION OPERATIONS. VOLUME I,
ERT, Pittsburgh, PA.
D. Wesolowski, A. Broughton, C. A. Hansotte, S. M. Koraido, and J. P. Fillo.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-173083. Price codes: A10 in paper copy, A01 in microfiche. Report No. GRI-87/0335.I, December 1987. Topical Report (July 1986 to December 1987). 253p, 21 tab, 20 ref, 4 append. Gas Research Institute Contract 5084-253-1117.

Descriptors: *Pollutant identification, *Wastewater treatment, *Natural gas, Organic compounds, Metals, Dissolved solids, Chlorides, Sodium, Calcium Aromatic compounds, Phenols.

The objective of this program was to investigate the characteristics of production waters from natural gas industry operations and the practices currently employed by the industry to manage these waters. The characteristics of produced waters are highly variable and site-specific. Produced waters generally contain volatile organics, including aromatic hydrocarbons. Semivolatile organics, primarily straight-chain alkanes, selected PAH, and phenols are raw gas produced. Selected trace elements are present in produced waters from natural gas production operations. Specific constituents and concentrations are dependent on the characteristics of the producing formation. The most predominant trace elements detected were barium, lithium, magnesium, potassium, and strontium. Conventional water quality parameters are highly variable in produced waters, consistent with the specific trace elements and organic constituents. Dissolved solids, including chlorides, sodium, and calcium, were the most predominant conventional parameters detected. Based on these results, a number of compounds can be eliminated from further characterization studies of produced waters because they were not detected in any samples. This includes most of the metals included in the qualitative Superscan search and many of those quantified by inductively coupled plasma emission spectroscopy and atomic absorption spectrophotometry. A number of organic compounds (e.g., many of the halogenated hydrocarbons) could also be eliminated from further study. (See also W89-04886) (Lantz-PTT)
W89-04887

CHARACTERIZATION OF PRODUCED WATERS FROM NATURAL GAS PRODUCTION OPERATIONS. VOLUME II,
Radian Corp., Austin, TX.
L. H. Keith, S. K. Mertens, F. L. Shore, M. C. Shepherd, and P. J. Schrynemeeckers.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-173091. Price codes: A06 in paper copy, A01 in microfiche. Report GRI-87/0335.2, December 1987. Topical Report (July 11986 to December 1987). 150p, 12 tab, 3 append. Gas Research Institute contract 5084-253-1117.

Descriptors: *Pollutant identification, *Natural gas, *Chemical analysis, *Drilling muds, Toxicity, Oil, Water analysis, Quality control, Data acquisition.

Drilling muds, produced water and associated oil and gas exploration and production wastes are currently exempt from hazardous waste regulation in accordance with Resource Conservation and Recovery Act (RCRA) Section 3001 (b)(2)(A). There is a general lack of comprehensive data on the chemical characteristics of produced waters. Specifically, waters from non-associated gas operations are not well characterized. An EPA study focuses primarily on produced waters from oil and oil/gas production operations and evaluates few samples of produced waters from non-associated gas production. The Gas Research Institute (GRI) planned a sampling program to obtain and analyze produced water from gas production operations not associated with oil production, which includes the following major technical aspects: a total of 17 produced water samples; geographical distribution of the samples based on statistics for natural gas production and number of wells; and analytes and analytical methodology to parallel that of the EPA study. Produced waters contained volatile organics and selected semivolatile organics. Cations and trace elements were also present, particularly sodium, calcium, potassium, and strontium. Chloride and total dissolved solids were the major conventional parameters detected. Produced water from two of the sites exceeded barium limits for the Extraction Procedure (EPA) Toxicity test. The results were qualitatively consistent with the EPA and American Petroleum Institute characterization programs. All three studies confirm that produced waters do not consistently exhibit any of the current RCRA characteristics of recovery, reactivity, ignitability, or EP toxicity. (See also W89-04886) (Lantz-PTT)
W89-04888

QUALITY-ASSURANCE RESULTS FOR FIELD PH AND SPECIFIC-CONDUCTANCE MEASUREMENTS, AND FOR LABORATORY ANALYSIS, NATIONAL ATMOSPHERIC DEPOSITION PROGRAM AND NATIONAL TRENDS NETWORK--JANUARY 1980-SEPTEMBER 1984,
Geological Survey, Denver, CO. Water Resources Div.
L. J. Schroder, M. H. Brooks, B. A. Malo, and T. C. Willoughby.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4139, 1986. 32p, 6 fig, 18 tab, 19 ref.

Descriptors: *Water analysis, *Chemical analysis, *Pollutant identification, *Acid rain, *Quality assurance, *Hydrogen ion concentration, *Conductance, Chemistry of precipitation, Laboratories, Comparison studies, Anions, Cations, Simulated rainfall, Standard deviation, Sample preparation, Precision, Analysis of variance.

Five intersite comparison studies for the field determination of pH and specific conductance, using simulated-precipitation samples, were conducted by the U.S.G.S. for the National Atmospheric Deposition Program and National Trends Network. These comparisons were performed to estimate the precision of pH and specific conductance determinations made by sampling-site operators. Simulated-precipitation samples were prepared from nitric acid and deionized water. The estimated standard deviation for site-operator determination of pH was 0.25 for pH values ranging from 3.79 to 4.64; the estimated standard deviation for specific conductance was 4.6 microsiemens/cm at 25 C for specific-conductance values ranging from 10.4 to 59.0 microsiemens/cm at 25 C. Performance-audit samples with known analyte concentrations were prepared by the U.S.G.S.and distributed to the National Atmospheric Deposition Program's Central Analytical Laboratory. The differences between the National Atmospheric Deposition Program and national Trends Network-reported analyte concentrations and known analyte concentrations were calculated, and the bias and precision

were determined. For 1983, concentrations of calcium, magnesium, sodium, and chloride were biased at the 99% confidence limit; concentrations of potassium and sulfate were unbiased at the 99% confidence limit. Four analytical laboratories routinely analyzing precipitation were evaluated in their analysis of identical natural- and simulated precipitation samples. Analyte bias for each laboratory was examined using analysis of variance coupled with Duncan's multiple-range test on data produced by these laboratories, from the analysis of identical simulated-precipitation samples. Analyte precision for each laboratory has been estimated by calculating a pooled variance for each analyte. Interlaboratory comparability results may be used to normalize natural-precipitation chemistry data obtained from two or more of these laboratories. (Author's abstract)
W89-04920

COMPARISON OF MUSSELS AND CRUSTACEAN PLANKTON TO MONITOR HEAVY METAL POLLUTION,
Balatoni Limnologiai Kutato Intezete, Tihany (Hungary).
K. V. Balogh.
Water, Air, and Soil Pollution WAPLAC, Vol. 37, No. 3-4 p 281-292, February 1988. 8 fig, 1 tab, 28 ref.

Descriptors: *Bioindicator, *Mussels, Plankton, *Heavy metals, *Water pollution effects, *Zooplankton, Water pollution, Path of pollutants, Effluents, Hungary, Waterfleas, Copepods.

The ability of freshwater organisms (mussels - Unio pictorum L. and crustacean plankton - Cladocera and Copepoda species) to monitor heavy metal pollution was compared under field conditions, near the effluent discharge of a sewage water treatment plant at Lake Balaton (Hungary). The mussels were transferred from the less polluted habitat to the study area. The crustacean plankton was collected at this site. The concentrations of Hg, Cd, Cr, Cu, Pb, Zn, and Fe were measured in the gills of the transplanted mussels as well as the natural zooplankton in the summer period, using the atomic absorption spectroscopy method. Both mussel gills and the zooplankton showed periodically high Fe, Zn and Cu concentrations. An elevated level of Hg was only observed in mussels, while high Pb and Cr concentrations were found only in crustacean plankton. Accordingly, the zooplankton seems a more suitable model for monitoring heavy metal pollution under these field conditions. (Author's abstract)
W89-04972

EVALUATING SOLUBLE TOXICANTS IN CONTAMINATED SOILS,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Biology.
J. R. Pratt, P. V. McCormick, K. W. Pontasch, and J. Cairns.
Water, Air, and Soil Pollution WAPLAC, Vol. 37, No. 3-4 p 293-307, February 1988. 3 fig, 8 tab, 27 ref.

Descriptors: *Soil analysis, *Soil contamination, Leaching, Leachates, *Toxicity, Agricultural soil.

The potential toxicity of leachable materials from seven soils was evaluated. Five soil samples were obtained at designated toxic or hazardous waste sites, and two additional soil samples were obtained from a coal storage area and from an agricultural field. Acidified tap water (pH 4.5) was used to extract toxic materials from elution columns filled with soil samples. Extracts were used as complex mixtures to conduct acute toxicity tests using aquatic microcosms. Three classes of effects were observed. Three soil leachates showed acute and chronic toxicity at less than 3% leachate. Two of these soils were contaminated by materials used in wood preserving, and the third soil was contaminated with heavy metals and acid. Two soils showed moderate acute toxicity but no chronic toxicity in microcosm tests. One of these soils was from a reference agricultural field while the other soil was contaminated with solvents. The failure to detect toxicity in the solvent contaminated sample was attributed to the hydrophobicity of the toxicity materials. Results of these toxic screening are in the same range as leachate toxicities estimated using other methods, although other methods use extraction materials that may interfere with some biological tests. Toxicological evaluations of materials from suspected contaminated soil are recommended for prioritizing clean-up efforts at waste sites and for determining if toxic materials and contaminated soils have been effectively removed. (Author's abstract)
W89-04973

CHRYSOPHYTE SCALES IN LAKE SEDIMENTS PROVIDE EVIDENCE OF RECENT ACIDIFICATION IN TWO QUEBEC (CANADA) LAKES,
Trent Univ., Peterborough (Ontario). Trent Aquatic Research Centre.
For primary bibliographic entry see Field 5C.
W89-04988

COMPARISON OF THE STANDARD AND DIRECT-MPN METHODS FOR FAECAL COLIFORM ENUMERATION IN SOME NIGERIAN WATERS,
Port Harcourt Univ. (Nigeria). Dept. of Microbiology.
M. T. Ogan.
Water, Air, and Soil Pollution WAPLAC, Vol. 38, No. 3-4, p 255-262, April 1988. 1 fig, 3 tab, 13 ref. University of Port Harcourt Senate Research Grant UPH/REG./COM5.4.

Descriptors: *Pollutant identification, *Culture media, *Culturing techniques, *Nigeria, *Coliforms, Estimating, *Bacterial analysis, Fecal coliforms, Standard MPN, Brilliant Green Bile broth, Comparison studies.

The Standard and Direct-MPN (direct incubation at 44.5 C) methods were compared in estimating fecal coliforms in some Nigerian surface waters. Brilliant Green Bile broth plus indole test at 44 C was substituted for E.C. broth in the Standard test. The results show that the use of the MacConkey was better than Brilliant Green Bile broth; counts were higher in the MacConkey by a factor of up to 70. Contrary to several other reports, the Direct-MPN counts were equal to or higher than the Standard method when subcultures were made into MacConkey broth in only 13 (43%) or into Brilliant Green Bile broth in 25 (83%) samples. The ratios of counts by the Standard vs Direct-MPN were positively and significantly correlated with non-filterable residues. Of the 201 isolates obtained from the 30 samples by the Direct-MPN, 199 (99%) were E. coli and 2 (1%) were irregulars. (Author's abstract)
W89-04994

BORON CONTENT IN FRESHWATERS OF NORTHERN ITALY,
Istituto di Ricerca sulle Acque, Brugherio (Italy). Reparto Sperimentale di Idrobiologia Applicata.
For primary bibliographic entry see Field 5B.
W89-05002

SUMMER PRIMARY PRODUCTIVITY AND ASSOCIATED DATA FOR FOUR INDIANA RIVERS,
Indiana Dept. of Environmental Management, Indianapolis. Water Quality Surveillance and Standards Branch.
C. L. Bridges, H. L. BonHomme, G. R. Bright, D. E. Clark, and J. K. Ray.
Proceedings of the Indiana Academy of Science PIACAP, Vol. 96, p 309-314, 1986. 2 fig, 3 tab, 11 ref.

Descriptors: *Indiana, *Rivers, *Water quality, *Primary productivity, Chlorophyll a, Phytoplankton, Periphyton, Macrophytes, Summer, Wabash River, St. Joseph River, White River, Trail Creek.

A variety of summertime measurements of primary productivity taken during the years 1981 to 1984 are reported for four Indiana rivers: (1) Wabash River, (2) East Fork of the White River, (3) Trail Creek, and (4) St. Joseph River. The chlorophyll a concentrations at different depths as well as physical and chemical data for three stations on the Wabash River are shown. It was apparent from these and many other similar measurements that the Wabash River was well mixed for physical, chemical and phytoplankton components during summer low flow conditions from surface to bottom and from bank-to-bank. Chlorophyll a, primary productivities, and phytoplankton cell count data for the four rivers are presented. The East Fork of the White River, Trail Creek, and the St. Joseph River have lower chlorophyll a concentrations, primary productivity rates and phytoplankton densities in comparison to the middle Wabash River. All three of these smaller rivers also receive municipal and industrial effluents but never generate the same level of planktonic densities, chlorophyll a concentration or planktonic primary production rates. It should be noted that none of the rivers in the location studied, including the Wabash, had any significant amount of periphyton or macrophytes. (Miller-PTT)
W89-05003

USE OF ANILINE AS AN INDICATOR OF PERSISTENCE IN ENVIRONMENTAL STUDIES,
Lilly (Eli) and Co., Indianapolis, IN. Lilly Research Lab.
R. M. Kline, and C. A. Schmalz.
Proceedings of the Indiana Academy of Science PIACAP, Vol. 96, p 371-376, 1986. 2 fig, 7 tab, 8 ref.

Descriptors: *Fate of pollutants, *Pesticides, *Chemical degradation, *Path of pollutants, *Biodegradation, *Degradation, *Acclimation, *Aromatic compounds, *Indicators, *Aniline, Acclimation, Persistence.

The feasibility of using non-acclimated sewage organisms as an indicator of relative persistence within a group of experimental pesticides was studied. Aniline was selected in these tests because the aromatic structure is basic to several pesticides. It was anticipated that the compound may also be used to predict relative persistence of experimental pesticides under field conditions. Aniline rapidly degraded in sewage without an acclimation period. The test compound was added at concentrations equal to or less than 10 ppm which would approximate the concentration of pesticides used on agronomic cropland. The compound, as suggested by the OECD and the EPA, would appear to be a good indicator of environmental degradation in soil. The rapid degradation of aniline in the test systems prevents its use as a comparative reference to measure the relative persistence of slowly degrading products. (Miller-PTT)
W89-05005

FAST-NEUTRON-ACTIVATION ANALYSES OF VARIOUS WATER SOURCES OF EAST CENTRAL INDIANA,
Ball State Univ., Muncie, IN. Dept. of Physics and Astronomy.
D. S. Bennett, M. J. Buchkowski, C. A. Bye, D. L. Lowenstein, and D. R. Ober.
Proceedings of the Indiana Academy of Science PIACAP, Vol. 96, p 387-395, 1986. 5 fig, 2 tab, 5 ref.

Descriptors: *Water analysis, *Chemical analysis, *Indiana, *Water supply, *Trace elements, *Heavy metals, *Neutron activation analysis, *Pollutant identification, Drinking water, Aluminum, Calcium, Chloride, Barium, Iron, Manganese, Potassium, Sodium, Strontium, Sensitivity analysis.

The documentation of regional fluctuations in the concentrations of certain trace elements found in the water samples was investigated. The study included local sampling sites representing both river and drinking water supplies. At three of the drinking water sites, multiple samples were taken at different times in an effort to study the time dependence of trace elements and to check the reproducibility of results. Fast neutron activation analysis was used in an effort to determine the

trace element composition of various northeastern Indiana water supplies. This method proved to be successful in identifying and determining the concentration of nine elements commonly found in water supplies. The following elements were identified both qualitatively and quantitatively: (1) aluminum, (2) barium, (3) calcium, (4) chlorine, (5) iron, (6) magnesium, (7) potassium, (8) sodium, and (9) strontium. Silicon was also detected but only qualitative comparisons were done since silicon is found in all water samples. For the most part, calcium, magnesium, potassium and sodium were found in gross amounts, whereas aluminum, barium, iron, and strontium were found in trace quantities. The overall sensitivity of neutron activation analysis was in the ppm range; this estimate was substantiated by the fact that results by the neutron activation analysis were in excellent agreement with atomic absorption spectroscopy measurements to within specified uncertainties. (Miller-PTT)
W89-05006

METHOD FOR DETERMINING METAL SPECIES IN SOIL PORE WATER,
Queen's Univ., Kingston (Ontario). Dept. of Chemistry.
S. J. Duffy, G. W. Hay, R. K. Micklethwaite, and G. W. Vanloon.
Science of the Total Environment STENDL, Vol. 76, No. 2/3, p 203-215, October 15 1988. 3 fig, 6 tab, 20 ref.

Descriptors: *Soil water, *Pollutant identification, *Acid rain, *Water analysis, *Ion exchange, *Heavy metals, *Metals, *Aluminum, Calcium, Potassium, Magnesium, Manganese, Sodium, Soil porosity, *Path of pollutants.

A method for the analysis of complexed and uncomplexed metals in soil pore water samples has been developed by applying sequential anion and cation separations (IX), followed by neutron activation analysis on the separate solutions. Six metals (Al, Ca, K, Mg, Mn, and Na) were determined, and their relationships to pH and dissolved organic carbon were studied. The aluminum separation results were compared with results obtained by two established procedures for determining solution species of aluminum. There was reasonable agreement between the speciation results obtained by the IX and solvent extraction methods but for undetermined reasons, the concentrations of inorganic Al using the fluoride ion-selective electrode method were about five times lower than from the IX procedure. The ion exchange separation may be combined with another analytical method, if desired. (Miller-PTT)
W89-05017

RHOCO2 VARIATIONS IN STREAMWATERS DRAINING AN ACIDIC AND ACID SENSITIVE SPRUCE FORESTED CATCHMENT IN MID-WALES,
Institute of Hydrology, Wallingford (England).
For primary bibliographic entry see Field 5B.
W89-05020

COLIPHAGES AND ENTERIC VIRUSES IN THE PARTICULATE PHASE OF RIVER WATER,
Institut Armand-Frappier, Laval (Quebec). Centre de Recherche en Virologie.
For primary bibliographic entry see Field 5B.
W89-05021

CONFIRMATION OF A MAMMALIAN POISON CLASSIFICATION USING A WATER FLEA (DAPHNIA MAGNA) SCREENING METHOD,
Industrial Toxicology Research Centre, Lucknow (India). Preventive Toxicology Div.
B. S. Khangarot, and P. K. Ray.
Archiv fuer Hydrobiologie AHYBA4, Vol. 113, No. 3, p 447-455, September 1988. 2 fig, 6 tab, 33 ref.

Descriptors: *Toxicity, *Daphnia, *Bioassay, *Heavy metals, Poisons, Mercury, Copper, Iron, Zinc Cadmium, Tin, Pentachlorophenol, 2,4-Dichlorophenoxyacetic acid, Pentachlorophenol, Methanol, Ethanol.

The screening of toxic compounds using mammalian test models is time consuming and expensive. It was proposed that satisfactory classification of mammalian poisons could be obtained using a simple and inexpensive water flea (Daphnia magna) screening method. Acute toxicity values (EC50) were determined for D. Magna using a wide variety of mammalian toxicants and on a number of water pollutants affecting safe drinking water and human health, representing a range of toxicity classes. Inorganic compounds tested were mercuric chloride, silver nitrate, cupric chloride, cadmium chloride, zinc chloride, lead acetate, nickel chloride, ferric chloride, stannous chloride and sodium chloride; organic compounds, were 2,4-dichlorophenoxy acetic acid, pentachlorophenol, bromoform chloroform, carbon tetrachloride, methanol and ethanol. For the toxic compounds tested a strong correlation ($r=0.992$) existed between Daphnia EC50 and rat LD50 values. A correlation analysis demonstrated an overall Spearman rank correlation coefficient of 0.956 for rat and 0.924 for mouse. With few exceptions, the toxicity classes were the same as those determined for rodents. The relatively short life cycle and 48-h duration of test, small water volume needed, ease of handling, high fecundity and good correlation between the EC50 values and the rodent LD50 values strongly suggest that the Daphnia microbioassay can become an alternative for rapid screening of potentially toxic compounds. (Author's abstract)
W89-05028

CHIRONOMIDS AS WATER QUALITY INDICATORS IN THE RIVER MIGNONE (CENTRAL ITALY),
Universita degli Studi 'La Sapienza', Rome (Italy). Dipt. di Biologia Animale e dell 'Uomo.
M. Bazzanti, and F. Bambacigno.
Hydrobiological Bulletin HYBUD9, Vol. 21, No. 2, p 213-222, December 1987. 3 fig, 4 tab, 39 ref.

Descriptors: *Water pollution, *Water quality, *Bioindicators, *Midges, Mignone River, Italy, Rivers.

Chironomids of the River Mignone (Central Italy) were studied in order to examine their community structure and their relationship to some common biological indices (Biotic Score, Extended Biotic Index, Indice Biotique de Qualite Generale) utilizing the total macroinvertebrate fauna (chironomids generally at family level) for water quality assessment in rivers. A total of 36 taxa belonging to Tanypodinae (2 taxa), Orthocladiinae (22 taxa) and Chironominae (12 taxa) was collected at 7 stations four times during the year. The results support the importance of the chironomid identification in water quality assessment studies in rivers, and demonstrate the usefulness of the factorial correspondence analysis as ordination technique based on both qualitative and quantitative chironomid data to determine environmental quality gradients. The value as bioindicator of some taxa and chironomid assemblages were related to biological water quality of the river according to functional feeding groups. The distribution of chironomid larvae in the River Mignone can be summarized as follows: Higher percentages of Chironominae and shredders, and of lower percentages of Pentaneurini and predators occur in polluted waters, with respect to unpolluted stations; An Eukiefferiella claripennis, Paratrichocladius rufiventris, Chironomus riparius assemblage occurs in polluted conditions; The taxonomic identification of chironomids in water quality assessment studies in rivers is very important, considering the relationship between this dipteran family and the most common biological indices. (Author's abstract)
W89-05044

DEFINED SUBSTRATE TECHNOLOGY FOR THE ENUMERATION OF MICROBIAL INDICATORS OF ENVIRONMENTAL POLLUTION,
Yale Univ., New Haven, CT. School of Medicine.
S. C. Edberg, and M. M. Edberg.
Yale Journal of Biology and Medicine YJBMAU, Vol. 61, No. 5, p 389-399, September-October 1988. 2 fig, 2 tab, 33 ref.

Descriptors: *Pollutant identification, *Bioindicators, *Coliforms, *Escherichia coli, *Public health, *Water analysis, Culturing techniques, Microbiological studies, Water pollution.

There are two accepted methods for examination of water and other environmental sources for microbial pollution: the multiple-tube fermentation and the membrane filtration tests. Both methods are designed to enumerate the secondary indicator group, total coliforms. Both tests suffer several inherent limitations, including a time delay of 3-7 days to obtain a definitive result, the subjective nature of the test interpretation, and the ability to provide directly useful public health information. A defined substrate technology, originally used to enumerate specific bacterial species from mixtures in clinical urine specimens, was applied to water testing. The technology was constituted to enumerate simultaneously both total coliforms and the primary indicator bacterium E. coli. Examination of environmental isolates of these two classes of target microbes showed sensitivity equal to available methods, with potentially greater specificity. It was not subject to inhibition by bacteria other than the targets, grew injured coliforms, did not require confirmatory tests, and the maximum time to a positive was 24 hours. The defined substrate technology provides both regulatory and directly useful public health information. (Author's abstract)
W89-05051

CHLORINATED DRINKING WATER IS MUTAGENIC AND CAUSES 3-METHYLCHOLANTHRENE TYPE INDUCTION OF HEPATIC MONOOXYGENASE,
National Public Health Inst., Kuopio (Finland). Dept. of Environmental Hygiene and Toxicology.
For primary bibliographic entry see Field 5F.
W89-05052

NUMERICAL WATER ASSESSMENT OF RIVERS IN HOKURIKU DISTRICT USING EPILITHIC DIATOM ASSEMBLAGE ON RIVER BED AS A BIOLOGICAL INDICATOR: 1. THE VALUES OF DIATOM ASSEMBLAGE INDEX TO ORGANIC WATER POLLUTION (DAI PO),
M. Sumita.
Japanese Journal of Limnology RIZAA, Vol. 49, No. 2, p 99-108, April 1988. 3 fig, 2 tab, 26 ref. English summary.

Descriptors: *Water quality, *Diatoms, *Bioindicators, *Pollution index, *Pollutant identification, River basins, Ecologic effects, Species composition, Japan, Numerical analysis.

In this study Diatom Assemblage Index (DAIpo) to organic water pollution values of 418 samples were obtained at 183 stations in 52 rivers in the Hokiriku District. The average DAI values and the histogram of the distribution of DAI values were obtained in several river basins. From their data the state of the organic water pollution of the investigated rivers was examined. In the histograms of the distribution of DAIpo, the modes were of higher grades, suggesting that there are many clean water areas in river basins of that area. Some 25 taxa were chosen as dominant species. The ecological ciassification of these taxa according to their tolerance to the degrees of organic water pollution corresponded fairly well with a previous classification. A pollution spectrum was made for the above-mentioned 25 taxa which showed the change of dominant species was made according to the degrees of organic water pollution based on DAIpo. Its purpose is to determine the suitability of the values of DAIpo as biological information. As a result, DAI values were found to be a proper indicator of water quality in comparatively clean rivers of the Hokuriku District. (Author's abstract)
W89-05071

VALIDITY OF AN ECOTOXICOLOGICAL TEST SYSTEM: SHORT-TERM AND LONG-TERM EFFECTS OF ARSENATE ON MARINE PERIPHYTON COMMUNITIES IN LABORATORY SYSTEMS,
Goeteborg Univ. (Sweden). Dept. of Botany.
H. Blanck, and S. A. Wangberg.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 45, No. 10, p 1807-1815, October 1988. 8 fig, 2 tab, 41 ref. National Swedish Environment Protection Board Grant 5333071-5333076.

Descriptors: *Bioindicators, *Phytotoxicity, *Water pollution effects, *Photosynthesis, *Arsenic compounds, Model testing, Testing procedures, Fjords, Biomass, Carbon, Nitrogen, Chlorophyll a, Prediction, Inhibition, Coastal waters, Sweden, Phosphorus.

Periphyton communities were established on glass substrates in the Gullmar Fjord (Sweden) and their sensitivity to arsenate was determined with short-term photosynthesis experiments. The study was done in May 1984 when phosphate levels were low. A 1-hour exposure to arsenate gave IC-20 (concentration required to inhibit photosynthesis by 20%) values of 0.4 microM. Communities established indoors in a flow-through aquaria system were substantially different from the fjord communities in terms of structure and biomass, although photosynthesis showed a similar sensitivity. To explore the validity of this short-term ecotoxicological system, a set of indoor, flow-through aquaria was used to study long-term effects (3 weeks) on communities established under arsenate stress. Arsenate was added continuously at 0.1-10 microM above background levels. Species composition as well as carbon, nitrogen, and chlorophyll a content of the communities were affected at 0.2-0.8 microM. This is in good agreement with the sensitivity of the short-term test. It can be concluded that inhibition of the physiological parameter photosynthesis is relevant information for the understanding of ecological events caused by arsenate stress in the periphyton communities. The short-term metabolic test system can be used for valid predictions of gross changes in periphyton community structure and production due to the effects of arsenate. Comparison with arsenic levels in polluted coastal areas of Sweden lead to the conclusion that periphyton communities may be affected, particularly when phosphorus levels are low. (See also W89-05106) (Author's abstract)
W89-05105

INDUCED COMMUNITY TOLERANCE IN MARINE PERIPHYTON ESTABLISHED UNDER ARSENATE STRESS,
Goeteborg Univ. (Sweden). Dept. of Botany.
H. Blanck, and S. A. Wangberg.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 45, No. 10, p 1816-1819, October 1988. 2 fig, 2 tab, 23 ref. National Swedish Environment Protection Board Grant 5333071-5333076.

Descriptors: *Bioindicators, *Tolerance, *Arsenic compounds, *Stress, *Water pollution effects, *Model testing, Selectivity, Species composition, Biomass, Prediction, Phytotoxicity, Photosynthesis, Testing procedures, Fjords, Sweden.

Pollution-induced community tolerance may be used to assess impact of pollutants in the environment and to identify the agents causing the impact. This possibility is examined using marine periphyton communities, which were established under arsenate stress in indoor aquaria and their community tolerance to arsenate estimated with a short-term photosynthesis test. Arsenate concentrations above 0.1-0.3 microM induced an increased tolerance to arsenate; at severe arsenate stress the increase in tolerance was more than 17,000-fold. The interpretation is that arsenic exerted a selection pressure on the community, leading to the replacement of sensitive species by tolerant ones which caused the overall arsenate tolerance of the community to increase. Arsenate concentrations that induced the tolerance also affected species composition and biomass accrual, suggesting that community tolerance can be used to properly indicate a disturbed community. Hence the basic requirements for the use of pollution-induced community tolerance are met. (See also W89-05105) (Author's abstract)
W89-05106

LIQUID NITROGEN PRETREATMENT IN ATP EXTRACTION FROM SEDIMENTS,
Parma Univ. (Italy). Ist. di Ecologia.
For primary bibliographic entry see Field 7B.
W89-05180

COMPARISON OF CHLOROPHYLL-A CONCENTRATIONS MEASURED BY FLUOROMETRIC HPLC AND SPECTROPHOTOMETRIC METHODS IN HIGHLY EUTROPHIC SHALLOW LAKE KASUMIGAURA,
National Inst. for Environmental Studies, Ibaraki (Japan).
For primary bibliographic entry see Field 7B.
W89-05181

YEARLY FLUX OF VIRUS-LIKE PARTICLES AND HUMIC ACID IN RIVER SEDIMENT,
Davidson Coll., NC. Dept. of Biology.
W. T. Lammers.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Vyerhandlungen IV TLAP, Vol. 23, No. 2, p 1219-1223, August 1988. 2 fig, 1 tab, 8 ref.

Descriptors: *Sediments, *Water analysis, *Colloids, *River sediments, *Samplers, *Viruses, New River, North Carolina, Virginia, Hydrogen ion concentration, Seasonal variation.

Colloidal particles do not settle out of suspension at one gravity. They will leave the sediment when conditions are alkaline or the electrolyte level is low. The sediment serves as a virus reservoir. Rain and snow melt may cause rapid dilution and pH shift in one direction as may drought, soil erosion, sewage inflow in another. In slow moving streams and lakes grab sampling of sediment is possible, but in turbulent streams with little sediment buildup an implanted long term trap is better. The New River, 4.8 km below the US highway 21 bridge along the North Carolina-Virginia border was chosen as a sampling station. An inverted 3 liter plastic soft drink bottle with the bottom cut off was used. About two-thirds of the bottle was filled with river rocks, it was set half its depth in the stream bed and surrounded by stones. The trap was removed, emptied, and replaced once a month. Certain particle peaks are present each month while others appear only occasionally. The number of particle bands increases in the fall and winter and drops in the spring and summer. The amount of nucleic acid is highest in the winter and spring, lowest in the fall and summer. It does not correlate well with particle peak number, total chart record are or river flow. The high in the fall and winter may mean that intact virus-like particles persist longer in cold water. The same types of virus-like particles found in the water column are found in the sediment. This study demonstrates that, at least under laboratory conditions, the particles may be released selectively from the sediment. In the river they probably serve as a reservoir of particles which can enter or leave the sediment depending on such conditions as pH and electrolyte concentration. (Davis-PTT)
W89-05210

TEST FOR DREDGED MATERIAL EFFLUENT QUALITY,
Waterways Experiment Station, Vicksburg, MS.
M. R. Palermo, and E. L. Thackston.
Journal of Environmental Engineering JOEDDU, Vol. 114, No. 6, p 1295-1309, December 1988. 5 fig, 1 tab, 25 ref.

Descriptors: *Effluents, *Dredging, *Testing procedures, *Spoil disposal, Sedimentation basins, Suspended solids, Contamination, Water quality, Water pollution sources.

The quality of effluent discharged from confined dredged material disposal areas is an environmental concern when the sediments to be dredged are contaminated. Suspended matter is subjected to sedimentation within the disposal area. The finer suspended particles are only partially removed from the supernatant water by sedimentation effluent along with dissolved contaminants. This study developed a workable and easily applied technique for prediction of the quality of effluent from confined dredged material disposal areas. A modified elutriate test was developed to simulate the physicochemical conditions in confined disposal areas which would affect the release of contaminants. Factorial experiments were conducted to select appropriate test factors for simulating the oxidizing conditions and retention times present in confined disposal areas. The test was found to accurately predict the dissolved concentration of contaminants and the fractions of contaminants associated with the suspended solids in the effluent. (See also W89-05223) (Author's abstract)
W89-05222

VERIFICATION OF PREDICTIONS OF DREDGED MATERIAL EFFLUENT QUALITY,
Waterways Experiment Station, Vicksburg, MS.
M. R. Palermo, and E. L. Thackston.
Journal of Environmental Engineering JOEDDU, Vol. 114, No. 6, p 1310-1330, December 1988. 6 fig, 11 tab, 14 ref.

Descriptors: *Effluents, *Dredging, *Testing procedures, Spoil disposal, Suspended solids, Contamination, Water quality, Water pollution sources, Prediction, Sedimentation basins, Sediments.

Polluted sediments from harbors are often pumped to confined disposal areas on shore where they are settled. The polluted overflow effluent quality can now be predicted by a recently developed modified elutriate test. Predictions from this test were made for five major dredging jobs, and intensive sampling of the actual confined disposal area influents and effluents was done to check the accuracy of the prediction. Agreement ranged from fair to excellent for various pollutants. The median value of all ratios of predicted to measured total concentration was 1.4, and 23 out of 34 values were within a factor or 2.0. The Corps of Engineers has adopted the predictive method, and descriptions will be included in future Engineer Manuals as design guidance. (See also W89-05222) (Author's abstract)
W89-05223

GEOCHEMICAL MONITORING OF ATMOSPHERIC HEAVY METAL POLLUTION: THEORY AND APPLICATIONS,
E. A. Livett.
Advances in Ecological Research AELRAY, Vol. 18, p 65-177, 1988. 26 fig, 13 tab, 334 ref, append.

Descriptors: *Heavy metals, *Air pollution, *Path of pollutants, *Geochemistry, *Literature review, *Monitoring, *Water pollution sources, Reviews, History, Peat, Ice, Sediments, Data interpretation.

The three types of natural deposits that have used most extensively in monitoring the deposition of heavy metals from the atmosphere are peat, ice deposits and aquatic sediments. Their monitoring potential can be assessed from theoretical considerations and from proven applications. On theoretical grounds it is known that the initial uptake of airborne metals is achieved most effectively by peat overlain by vegetation, and least effectively by ice and snow. Peat, ice and aquatic sediments, with vastly differing accumulation characteristics and widely varying time-spans, provide pollution records with very different degrees of definition. It is easy to relate the heavy metal record in ice deposits to atmospheric heavy metal concentration or deposition rate, whereas in peat and aquatic sediments the relationship is more complicated and not always easy to quantify. Studies of the practical applications of geochemical monitoring have been carried out mainly in North-west Europe, North America and the remote polar regions, particularly in relation to the historical aspects of pollution. The importance of different sources of pollution has been studied by a variety of geo-

chemical monitoring approaches. A comparison of present-day deposition rates in Europe, North America and North Atlantic polar regions shows very wide variations in atmospheric heavy metal distribution in the northern hemisphere. The particular value of geochemical monitoring, in comparison with conventional and biological techniques, is that it portrays the global extent of atmospheric pollution in its full historical perspective. (VerNooy-PTT)
W89-05242

PRECIPITATION COMPOSITION AT CAPE GRIM, 1977-1985,
Commonwealth Scientific and Industrial Research Organization, Aspendale (Australia). Div. of Atmospheric Research.
G. P. Ayers, and J. P. Ivey.
Tellus TELLAL, Vol. 40B, No. 4, p 297-307, September 1988. 6 tab, 19 ref.

Descriptors: *Water chemistry, *Chemistry of precipitation, *Data acquisition, *Precipitation, *Rainfall, *Australia, *Marine climates, Salts, Chemical analysis, Sulfates, Hydrogen ion concentration, Hydrologic data collections, Air pollution.

Rainwater composition data resulting from monthly, wet-only collections of maritime rain at Cape Grim, Australia, in the period April 1977 to March 1985 have been critically appraised. High local wind speeds prove to be a major determinant of data quality: extremely high sea-salt loadings (average rainwater sodium and chloride concentrations in the low millimolar range) make estimation of excess sulfate impossible against a background sulfate concentration of about 150 microequivalent/L derived from sea-salt. The extreme wind speeds also cause considerable erosion of the Cape surface, leading to the ubiquitous presence of local soil components in collected rainwater. Both the rainwater data and data from the analysis of local soil samples show that these soil components significantly elevate rainwater pH (observed mean 6.01) and the concentrations of potassium and calcium. Effects upon other ions appear to be minimal, but cannot be ruled out. Calculation of pH for rainwater having the long-term mean composition, but with the effects of local contamination excluded, yielded a value of 5.10. Further calculations in which sea-salt content of the rainwater was varied over the range observed at Cape Grim indicated that at this site, sea-salt alkalinity may be a major determinant of rainwater pH, leading to pH variations from < 5 to > 6. (Author's abstract)
W89-05244

EFFECT OF SEWAGE TREATMENT PLANT EFFLUENTS ON THE DISTRIBUTION OF AQUATIC HYPHOMYCETES IN THE RIVER ERMS, SCHWABISCHE ALB, F.R.G.,
New Mexico State Univ., Las Cruces. Dept. of Biology.
For primary bibliographic entry see Field 5C.
W89-05259

GOALS AND DATA COLLECTION DESIGNS FOR WATER QUALITY MONITORING,
Inland Waters Directorate, Vancouver (British Columbia). Monitoring and Agreements Div.
For primary bibliographic entry see Field 7A.
W89-05267

WATER QUALITY IN THE PAWTUXET RIVER: METAL MONITORING AND GEOCHEMISTRY,
Rhode Island Univ., Narragansett. Graduate School of Oceanography.
For primary bibliographic entry see Field 5B.
W89-05269

STREAM CHEMISTRY IN THE SOUTHERN BLUE RIDGE: FEASIBILITY OF A REGIONAL SYNOPTIC SAMPLING APPROACH,
Environmental Protection Agency, Research Triangle Park, NC.
For primary bibliographic entry see Field 7A.
W89-05272

LEGIONELLA SPP. IN PUERTO RICO COOLING TOWERS,
Puerto Rico Univ., Rio Piedras. Dept. of Biology.
For primary bibliographic entry see Field 5B.
W89-05301

IMMUNOHISTOCHEMICAL DETECTION OF CCL4-INDUCED MITOSIS-RELATED DNA SYNTHESIS IN LIVERS OF TROUT AND RAT,
West Virginia Univ. Medical Center, Morgantown. Dept. of Pharmacology.
B. F. Droy, M. R. Miller, T. M. Freeland, and D. E. Hinton.
Aquatic Toxicology AQTODQ, Vol. 13, No. 2, p 155-166, October 1988. 9 fig, 27 ref. NSF Grant PCM 8316002, National Cancer Institute Grant CA 45131.

Descriptors: *Bioindicators, *Water pollution effects, *Morbidity, *Pollutant identification, *Trout, *Fish physiology, *Mutagenic effects, Liver, Biochemistry, Cell physiology, Population exposure.

Monoclonal antibodies (MAB) directed against 5-bromo, 2'deoxyuridine (BrdU) were used to detect cells in which carbon tetrachloride-induced DNA synthesis had occurred in livers of rainbow trout (Salmo gairdneri) and of rats. Trout exposed to CCl4 (single i.p. injection, 2.5 ml/kg) were injected 45 h later with BrdU (50 mg/kg); 3 h after BrdU administration, trout were sacrificed and livers were processed for immunohistochemistry and histopathology. Anti-BrdU immunohistochemical analysis revealed labeling of only occasional hepatocyte nuclei. On the other hand, in rats given a single i.p. injection of CCl4 (1.5 ml/kg) and injected 21 h later (3 h prior to sacrifice) with BrdU (50 mg/kg), immunohistochemistry revealed labeling of most hepatocyte nuclei. When control animals (not treated with CCL4) of both species were administered BrdU and processed for immunohistochemistry, no labeled hepatocyte nuclei were detected. MAB directed against BrdU proved useful in detecting chemically-induced replicative changes in liver cells from both trout and rat. Freeze-dried glycol methacrylate (GMA)-embedded tissue yielded excellent immunostaining and morphology. The immunohistochemical reaction appears particularly applicable to analyzing mitotic response and eliminates production of radioactive wastewater when analyzing chemically-induced nuclear changes in aquatic species. (Author's abstract)
W89-05316

REVIEW OF THE NATURE AND PROPERTIES OF CHEMICALS PRESENT IN PULP MILL EFFLUENTS,
Toronto Univ. (Ontario). Inst. for Environmental Studies.
L. R. Suntio, W. Y. Shiu, and D. Mackay.
Chemosphere CMSHAF, Vol. 17, No. 7, p 1249-1290, 1988. 5 fig, 5 tab, 181 ref.

Descriptors: *Pollutant identification, *Pulp wastes, *Chemical properties, *Toxicity, *Chlorinated hydrocarbons, *Phenols, *Reviews, *Structure-activity relationships, Pulp and paper industry, Effluents.

A compilation is presented of some 250 chemicals, including chlorinated hydrocarbons and phenols, identified in the effluents from pulp mills. The chemicals are categorized and available data on their environmentally relevant properties tabulated, including water solubility, vapor pressure, dissociation constant, and octanol-water partition coefficient. Data are also presented on the amounts produced, bioconcentration potential, and toxicity. It is concluded that available data on individual compound properties is not adequate to permit accurate assessments of environmental fate or effects. The number of chemicals is so large that there is a need to develop comprehensive quantitative structure-property-activity relationships to enable properties to be predicted rather than measured. Further, novel methods are needed to enable the cumulative effects of these many chemicals to be assessed, rather than treating chemicals on an individual bases. (Author's abstract)
W89-05330

DETERMINATION AND CHARACTERIZATION OF CHLOROGUAIACOL CONJUGATES IN FISH BILE BY HPLC,
Joensuu Univ. (Finland). Dept. of Biology.
A. O. J. Oikari, G. I. Baram, V. K. Evstafyev, and M. A. Grachev.
Environmental Pollution ENPOEK, Vol. 55, No. 2, p 79-87, 1988. 3 fig, 13 ref.

Descriptors: *Pulp wastes, *Bioindicators, *Tissue analysis, *Fish, *Fate of pollutants, *Biotransformation, *Chemical analysis, *Phenols, Metabolism, Liver, Industrial wastes, Wastes, Hydrocarbons, Chlorinated hydrocarbons, Lakes, Chemical reactions, Acids, Organic acids, Chromatography, Gas chromatography, Path of pollutants, Detoxification, High pressure liquid chromatography.

A small-scale technique is presented for direct analysis of metabolic conjugates of 4,5,6-trichloro-(CG-3) and tetrachloroguaiacols (CG-4) in fish bile by reversed phase HPLC. Only one metabolite, glucuronic acid conjugate, was demonstrated in two Lake Baikal fishes (Leuciscus leuciscus baikalensis and Cottus kessleri) exposed to CG-3 or CG-4 at 6 C for 1-2 days. In Leuciscus, the ratio between free CG-4 in the ambient water and conjugated CG-4 in the bile averaged 264,000. Intraperitoneal injections of tetrachloroveratrol (CV-4) into Thymallus arcticus baikalensis did not reveal any traces of free CV-4 or CG-4 glucuronide in the bile in 2 days at 5 C. It is concluded that CV-4 was not demethylated and subsequently conjugated with lucuronic acid in the liver of this fish species. (Author's abstract)
W89-05349

TRIBUTYLTIN CONTAMINATION AROUND AN OIL TERMINAL IN SULLOM VOE (SHETLAND),
Napier Coll. of Commerce and Technology, Edinburgh (Scotland).
For primary bibliographic entry see Field 5B.
W89-05355

DETERMINATION OF TRI-N-BUTYLTIN AND DI-N-BUTYLTIN COMPOUNDS IN YELLOWTAILS,
National Inst. of Hygienic Sciences, Tokyo (Japan).
K. Sasaki, T. Suzuki, and Y. Saito.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 41, No. 6, p 888-893, December 1988. 1 fig, 3 tab, 6 ref.

Descriptors: *Metal organic pesticides, *Fish, *Tin, *Pollutant identification, *Chemical analysis, *Tissue analysis, *Pesticides, Organic pesticides, Heavy metals, Chromatography, Gas chromatography, Sample preparation, Liver.

An analytical method for the determination of tri-n-butyltin and di-n-butyltin compounds uses one-step extraction, alkylation, silica gel column chromatography, and flame photometric detection. Detection limits for tri-n-butyl ethyltin and di-n-butyl diethyltin compounds were 0.05 ng. The procedure was used to assay tri- and di-n-butyltin compounds in liver and muscle tissue of yellowtails reared in marine farms. Almost all samples had levels above the detection limit. Di-n-butyltin dichloride was present at the highest levels in liver (0.025-3.7 micrograms/g) followed by red muscle and white muscle. Tri-n-butyltin chloride on the other hand was present in liver and red muscle at similar levels with the lowest levels in white muscle. Butyltin compounds were detected in both natural and reared fish. It is concluded that it is necessary to monitor tri- and di-n-butyltin compounds in both natural and reared fish. The proposed analytical method is suitable for the monitoring of these compounds in fish. (Doria-PTT)
W89-05362

HEAVY METAL POLLUTION FROM A POINT SOURCE DEMONSTRATED BY MUSSEL

(UNIO PICTORUM L.) AT LAKE BALATON, HUNGARY,
Balatoni Limnologiai Kutato Intezete, Tihany (Hungary).
K. V.-Balogh.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 41, No. 6, p 910-914, December 1988. 5 fig, 1 tab, 12 ref.

Descriptors: *Bioindicators, *Heavy metals, *Pollutant identification, *Water pollution sources, *Mussels, *Hungary, Indicators, Mollusks, Lake Balaton, Gills, Tissue analysis, Copper, Zinc, Cadmium, Lead, Water pollution effects, Spectroscopy, Atomic absorption spectroscopy, Marinas.

Concentrations of copper, zinc, lead, and cadmium were determined in the organs of freshwater mussel (Unio pictorum) taken from a sailing boat harbor at Balatonfured, Hungary, and compared to concentrations in mussels from the open water area of Lake Balaton. Determinations were by atomic absorption spectroscopy. The mussels living at harbor had significantly higher heavy metal concentrations compared with open water controls. Highest concentrations in the harbor mussels were found in the gills except for copper, where highest concentrations occurred in the mantle. The source of heavy metal pollution is believed to be antifouling and anticorrosive paints used for boat maintenance. (Doria-PTT)
W89-05365

APPARATUS FOR THE INVESTIGATION OF MICROBIAL REACTION RATES IN SEDIMENT SUSPENSIONS,
GKSS - Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.). Inst. fuer Chemie.
For primary bibliographic entry see Field 7B.
W89-05366

WATER HYACINTH (EICHHORNIA CRASSIPES) TO BIOMONITOR GENOTOXICITY OF LOW LEVELS OF MERCURY IN AQUATIC ENVIRONMENT,
Berhampur Univ. (India). Dept. of Botany.
B. B. Panda, B. L. Das, M. Lenka, and K. K. Panda.
Mutation Research MUREAV, Vol. 206, No. 2, p 275-279, October 1988. 2 tab, 20 ref. Government of India, Ministry of Environment and Forests Project 19/3/87-RE.

Descriptors: *Pollutant identification, *Aquatic environment, *Bioindicators, *Bioassay, *Bioindicators, *Monitoring, *Toxicity, *Mercury, *Water hyacinth, Indicators, Assay, Trace metals, Heavy metals, Roots, Plant tissues, Water pollution.

The utility of water hyacinth (Eichhornia crassipes) for biomonitoring the genotoxicity of low levels of aquatic mercury is investigated. In one experiment, intact root meristems were subjected to 1 h acute exposure to water contaminated with maleic hydrazide (MH) or methyl mercuric chloride (MMCl), followed by recovery in tap water. In a second experiment, the roots were subjected to 96 h exposure to water contaminated with MH or MMCl. In both experiments, the cytological end-point measured was the frequency of cells with micronuclei (MNC). In the first experiment, while in the MH-exposed root meristems the frequency of MNC was significant at 40 h of recovery, MMCl induced significant MNC at 12, 20, 24, 40, and 48 h of recovery depending on the concentration. In the second experiment, both test chemicals induced MNC which was concentration-dependent in case of MMCl. The highest ineffective concentration tested and lowest effective concentration tested for MMCl determined in this experiment were 0.0005 ppm and 0.001 ppm, respectively. It is concluded that E. crassipes could be a promising in situ environmental biomonitoring assay system. (Author's abstract)
W89-05368

ADVANCED INSTRUMENTAL METHODS FOR ANALYZING ORGANICS IN SOLID WASTE: THE USE OF GAS CHROMATOGRAPHY/MATRIX ISOLATION INFRARED SPECTROSCOPY (GC/MIIR) AND SUPERCRITICAL FLUID CHROMATOGRAPHY (SFC) FOR WASTE CHARACTERIZATION,
Argonne National Lab., IL. Analytical Chemistry Lab.
L. A. Raphaelian, A. S. Boparai, and J. F. Schneider.
Available from the National Technical Information Service, Springfield, VA 22161 as DE88-006004. Price codes: A02 in paper copy, A01 in microfiche. Report No. CONF-871041--5, 1988. 9p, 5 fig, 1 tab, 2 ref. DOE Contract W-31-109-Eng-38.

Descriptors: *Chemical analysis, *Aromatic compounds, *Mine wastes, *Organic compounds, *Solid wastes, *Pollutant identification, *Gas chromatography, Infrared spectroscopy, Chromatography, Chemical analysis, Measuring instruments, Dimethyl naphthalene, Coal.

Objectives of this study were: (1) to enhance the capabilities of analyzing the complex mixtures found in coal wastes by using gas chromatography/matrix isolation infrared spectroscopy (GC/MIIR), an instrument developed at Argonne National Laboratory; and (2) To separate, by supercritical fluid chromatography (SFC), the complex mixtures found in coal wastes into a few, less-complex mixtures so that analysis by gas chromatography (GC/MS) and GC/MIIR would be simplified. Studies conducted: demonstrated the ability of GC/MIIR to differentiate between isomers; quantified the amount of dimethyl naphthalene isomers in a coal waste sample; began constructing a library/data base of matrix isolation infrared spectra of compounds normally found in coal wastes; found GC/MIIR to be at least an order of magnitude more sensitive than light-pipe GC/IR; and tested a series of standards on SFC to establish performance (polynuclear aromatic hydrocarbons up through eight rings were chromatographed). (Lantz-PTT)
W89-05396

STANDARD METHODS FOR THE EXAMINATION OF WATER AND WASTEWATER.
American Public Health Association, Washington, DC.
American Public Health Association, Washington, DC. 1985. 1268p. Edited by Mary Ann H. Franson.

Descriptors: *Water analysis, *Wastewater analysis, *Standards, *Pollutant identification, Metals, Inorganic compounds, Organic compounds, Bioassay, Microbiological studies, Biological studies, Chemical analysis, Physical analysis.

In 1899, the American Public Health Association (APHA) appointed a Committee on Standard Methods of Water Analysis, charged with the extension of standard procedures to all methods involved in the analysis of water; water and wastewater combined. The committee report, published in 1905, constituted the first edition of 'Standard Methods'. By the Fourteenth Edition, the separation of test methods for water from those for wastewater was discontinued. All methods for a given component or characteristic appeared under a single heading. The coordination of methods was reflected in the revised numbering system. The major divisions of the Fourteenth and Fifteenth Editions were as follows: Part 100--General Introduction, Part 200--Physical Examination, Part 300--Determination of Metals, Part 400--Determination of Inorganic Nonmetallic Constituents, Part 500--Determination of Organic Constituents, Part 600--Automated Laboratory Analyses, Part 700--Examination of Water and Wastewater for Radioactivity, Part 800--Bioassay Methods for Aquatic Organisms, Part 900--Microbiological Examination of Water, and Part 1000--Biological Examination of Water. With minor differences, the organization of the Fourteenth Edition has been retained in this, the Sixteenth, edition. Changes which have been implemented include the adoption of the International System of Units (SI) and the use of trade names or proprietary materials has been eliminated insofar as possible, in order to avoid potential claims regarding restraint of trade or commercial favoritism. (Lantz-PTT)
W89-05429

CHARACTERIZATION OF WATER SOLUBLE COMPONENTS OF A WASTE WATER OIL SAMPLE FROM AN OIL SANDS BITUMEN UPGRADING PLANT,
Environmental Protection Service, Edmonton (Alberta).
D. A. Birkholz, S. E. Hrudey, B. J. Kimble, M. Rawluk, and M. Gray.
IN: Oil in Freshwater: Chemistry, Biology, Countermeasure Technology. Pergamon Press, New York, NY, 1987. Edited by John H. Vandermeulen and Steve E. Hrudey. p 42-57, 15 fig, 4 tab, 25 ref.

Descriptors: *Pollutant identification, *Oil pollution, *Oil, *Oil spills, Gas chromatography, Mass Spectrometry, Aromatic compounds, Hydrocarbons, Waste identification, Waste characteristics, Canada.

During the winter of 1981-1982, a fire and a series of equipment failures at the Suncor surface mining oil sands and bitumen upgrading plant, north of Ft. McMurray, Alberta, resulted in the release of more than 50 tons of oil (over several weeks) to the Athabasca River, under ice cover. A sample of oil collected from the plant's wastewater pond was subjected to exhaustive analysis to determine the presence of water soluble compounds likely to be harmful to fish or the Athabasca River fishery. Chemical characterization studies of the water soluble components were carried out using high pressure liquid chromatography, high resolution gas chromatography, high resolution gas chromatography - low resolution mass spectrometry and high resolution mass spectrometry. Analyses obtained for the base-neutral water soluble components revealed a very complex mixture of compounds. Further analytical work focused upon the identification of single ring aromatics, polycyclic aromatic hydrocarbons, polycyclic aromatic sulfur heterocycles, and polycyclic aromatic nitrogen heterocycles. These classes include compounds known to be toxic and/or susceptible to bioaccumulation by fish. Aromatic compounds predominated in the water soluble fraction. This is consistent with findings obtained for weathered oil/water samples. Compounds which were identified and absolutely confirmed include alkylated benzenes, alkylated benzothiophenes, and alkylated dibenzothiophenes. Compounds which were identified, but not taken to ultimate confirmation, included alkyl-substituted analogues of furan, indan, quinoline, monocycloalkanes, polynuclear aromatic hydrocarbons, monocycloketones, ketones and ketenes. (See also W89-04530) (Author's abstract)
W89-05435

ANALYSIS OF OIL AND GREASE COMPONENTS TO ASSESS THE QUALITY OF URBAN RUNOFF,
California Univ., Los Angeles. Dept. of Civil Engineering.
M. K. Stenstrom, S. Fam, and G. S. Silverman.
IN: Oil in Freshwater: Chemistry, Biology, Countermeasure Technology. Pergamon Press, New York, NY, 1987. Edited by John H. Vandermeulen and Steve E. Hrudey. p 138-148, 6 fig, 3 tab, 19 ref.

Descriptors: *Oil pollution, *Hydrocarbons, *Pollutant identification, *Water pollution sources, *Urban runoff, Organic compounds, Aromatic compounds, Water quality, Land use, Gas chromatography.

A technique modified from standard oil and grease testing procedures was used to examine runoff entering San Francisco Bay. This technique was developed to identify oil and grease fractions to provide a better understanding of environmental significance than indicated by oil and grease measurements. Samples were taken from fifteen different watersheds representing a variety of land uses. Collections were made during dry and wet weather conditions to represent the yearly diversity of water quality conditions. Organics were extracted with methylene chloride, virtually an identical approach to standard technique. Additional procedures were used to separate and quantify four

fractions: non-aromatic, aromatic, polar, and very polar. The aromatic and aliphatic fractions were examined using high resolution capillary gas chromatography. Oil and grease concentrations ranged from a low of 1.0 mg/L to as much as 20 mg/L. Dry weather oil and grease discharge was considerably less than wet weather discharge. Oil and grease from land associated with commercial and industrial activity had as much as 60% hydrocarbon fraction, while oil and grease from residential and undeveloped areas were composed primarily of polar, non-hydrocarbon compounds. Correlations between land use and water quality parameters were examined. Aliphatics were associated with commercial land use. The percent of the aliphatic fraction composed of n-alkanes of C25 and larger was inversely related to commercial land use. The aromatic fraction was more variable, with samples from non-commercial stations sometimes having very high aromatic fractions. (See also W89-04530) (Author's abstract)
W89-05441

ACUTE TOXICITY BIOASSAYS WITH PETROLEUM PRODUCTS: INFLUENCE OF EXPOSURE CONDITIONS,
Department of Fisheries and Oceans, Winnipeg (Manitoba). Freshwater Inst.
W. L. Lockhart, R. W. Danell, and D. A. J. Murray.
IN: Oil in Freshwater: Chemistry, Biology, Countermeasure Technology. Pergamon Press, New York, NY, 1987. Edited by John H. Vandermeulen and Steve E. Hrudey. p 335-344, 2 fig, 6 tab, 26 ref.

Descriptors: *Bioindicators, *Water pollution effects, *Bioassay, *Trout, *Oil pollution, *Aromatic compounds, *Toxicity, Hydrocarbons, Oil spills, Benzenes, Volatility, Testing procedures, Aeration, Ice cover.

Forty-eight hour-LC50 values (acute lethal toxicity) were obtained with young rainbow trout exposed to water-soluble fractions (WSF) of a range of crude and refined oils. The results were compared to the concentrations of volatile very low-boiling (< 115 C) and low-boiling (115-270 C) hydrocarbons determined by a two-stage analytical method. The first, consisting largely of alkanes, were determined by a headspace technique, while the second, consisting largely of substituted benzenes and naphthalenes, were analyzed by a solvent micro-extraction technique. The results suggest that toxicity of the water-soluble fractions is associated largely with the substituted benzenes and naphthalenes, with boiling points between 115 and 270 C. The LC50 values were highly dependent on the particular exposure conditions. Thus, survival of rainbow trout and their LC50 values were consistently higher in test containers that were open to the atmosphere than in sealed closed containers. Aeration of test containers, by bubbling air through the WSF, virtually eliminated toxicity to the trout in even the most toxic test preparations. These results are discussed in terms of the design of bioassays relevant to ice-covered environments and to other situations where volatilization may be low or reduced. (See also W89-04530) (Author's abstract)
W89-05452

SPECIAL POLLUTANTS,
McNeese State Univ., Lake Charles, LA. Dept. of Biological and Environmental Sciences.
For primary bibliographic entry see Field 5B.
W89-05531

EXPERIMENTAL METHODS,
McNeese State Univ., Lake Charles, LA. Dept. of Chemistry.
J. N. Beck.
In: Ecosystem Analysis of the Calcasieu River/Lake Complex (CALECO). Report No. DOE/EP/31111--1-Vol. 1, June 26, 1987. p 109-123, 13 refs. DOE Grant DE-FG01-83EP31111.

Descriptors: *Louisiana, *Pollutant identification, *Water analysis, *Sediments, *Heavy metals, *Metals, *Nutrients, *Calcasieu River, *Calcasieu Lake, Phosphate, Ammonia, Nitrate, Nitrite, Tissue analysis, Radiochemical analysis, Radioisotopes.

Water, sediment, and biota from the Calcasieu River/Lake Complex were analyzed for metals and nutrients. The concentrations of arsenic, cadmium, chromium, lead, and silver were determined using furnace atomic absorption analysis. Copper and zinc concentrations were determined by flame atomic absorption analysis and mercury by the cold vapor flameless atomic absorption technique. The nutrients, orthophosphate, ammonia, nitrate and nitrite were analyzed by standard EPA methods. Heavy metals concentrations were measured in selected tissue and dissected body parts using neutron activation analysis. In order to determine the approximate time periods in which various metals were deposited in sediments and to determine sedimentation rates, two radiochemical dating techniques were used (137Cs and ,210Pb) both of which are useful for dating sediments less than 100 yr old. (See also W89-05529) (Lantz-PTT)
W89-05533

PERIPHYTON AS MONITORS FOR HEAVY METAL POLLUTION IN THE CALCASIEU RIVER/LAKE COMPLEX,
McNeese State Univ., Lake Charles, LA. Dept. of Chemistry.
G. J. Ramelow, R. S. Maples, R. L. Thompson, C. S. Mueller, and C. Webre.
IN: Ecosystem Analysis of the Calcasieu River/Lake Complex (CALECO). Report No. DOE/EP/31111--1-Vol. 1, June 26, 1987. p 222-242, 3 fig, 2 tab, 15 ref. DOE Grant DE-FG01-83EP31111.

Descriptors: *Louisiana, *Bioindicators, *Monitoring, *Pollutant identification, *Periphyton, *Heavy metals, *Calcasieu River, *Calcasieu Lake, Arsenic, Cadmium, Chromium, Lead, Silver, Zinc, Diatoms, Sediment contamination.

The levels of the heavy metals As, Cd, Cr, Cu, Pb, Ag, and Zn were determined in periphyton specimens obtained with a diatometer collector. Stations were selected along three important bayous of the Calcasieu River system. Distributions of some of these metals in the organisms were similar to those found in sediments from the same locations, while those of other metals appeared to be similar to metal concentrations in water. Concentration ratios for periphyton to sediment greatly exceeded one for the metals As, Cd, Cr, Ag, and Zn, suggesting enrichment of these metals in periphyton. The concentrations of heavy metals in the periphyton appeared to yield more information about pollutants than either water or sediment samples collected at the periphyton stations. (See also W89-05529) (Author's abstract)
W89-05537

ANNUAL REPORT, ANALYSIS OF ACID PRECIPITATION SAMPLES COLLECTED BY STATE AGENCIES,
Global Geochemistry Corp., Canoga Park, CA.
For primary bibliographic entry see Field 5B.
W89-05759

MANAGEMENT SIGNIFICANCE OF BIOAVAILABLE PHOSPHORUS IN URBAN RUNOFF,
Washington Univ., Seattle. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5C.
W89-05782

ASSESSMENT OF RURAL GROUNDWATER CONTAMINATION BY AGRICULTURAL CHEMICALS IN SENSITIVE AREAS OF MICHIGAN,
Michigan State Univ., East Lansing. Inst. of Water Research.
For primary bibliographic entry see Field 7C.
W89-05784

5B. Sources Of Pollution

MODELS AND METHODS FOR SHALLOW CONDUIT-FLOW CARBONATE AQUIFERS,
Kentucky Univ., Lexington. Dept. of Geology.
J. Thrailkill.
IN: Proceedings of the Environmental Problems in Karst Terranes and Their Solutions Conference. National Water Well Association, Dublin, OH. 1986. p 17-31, 4 tab, 37 ref.

Descriptors: *Path of pollutants, *Groundwater pollution, *Aquifers, *Model studies, *Karst hydrology, Flow pattern, Conduits, Darcys law, Mathematical equations, Groundwater movement, Pumping tests, Tracers, Water chemistry.

Methods used to determine the extent of groundwater contamination, as well as those used to evaluate an aquifer as a water resource, must be based on a realistic conceptual model of the aquifer. In aquifers in which the significant voids are intergranular, these methods include determination of aquifer parameters by pumping test evaluation using the diffusion equation, mapping the head gradient from static water levels in wells, and delineating a contaminant plume by sampling down-gradient wells. All of these methods are based on a model of a flow continuum with Darcy flow down a smoothly varying head gradient. None of the features of this model are appropriate for the shallow conduit-flow carbonate aquifers which underlie many karst terranes, including the Paleozoic karst regions of the eastern mid-continent (North America). The model for these aquifers must reflect phenomena such as non-Darcy flow in conduits, often with a free surface, a dendritic flow pattern, highly heterogeneous aquifer parameters, and the existence of both major and minor flow systems. Methods consistent with such a model include water tracing techniques, which yield both qualitative information on the destination of contaminants introduced into the aquifer and quantitative data on aquifer parameters for major flow systems. Other appropriate methods include determination of aquifer parameters for the minor flow systems sampled by wells by drawdown interval analysis of data from pumping and recovery tests. (See also W89-04586) (Author's abstract)
W89-04588

PREDICTION OF CONTAMINANT PATHS IN KARST AQUIFERS,
State Univ. of New York Coll. at Oneonta.
A. N. Palmer.
IN: Proceedings of the Environmental Problems in Karst Terranes and Their Solutions Conference. National Water Well Association, Dublin, OH. 1986. p 32-53, 8 fig, 1 tab, 14 ref.

Descriptors: *Groundwater pollution, *Path of pollutants, *Aquifers, Geologic mapping, Karst, Groundwater movement, Flow pattern, Conduits, Vadose water, Perched groundwater.

Field data were gathered for conduit flow fed by point sources (sinkholes, sinking streams) and draining to discrete springs. In general the data do not fit a normal distribution, as they have sharp peaks governed by non-random geologic controls. However, by determining the probabilities for conduit orientation in a variety of geologic settings, it was possible to estimate the directions of water flow and contaminant transport within crude confidence intervals. Vadose flow was surprisingly concordant to the strata, even in many well-fractured rocks, and perched water was able to flow laterally as much as several kilometers before reaching the water table. Contaminants were therefore able to migrate across groundwater divides on their way downward through the vadose zone. Although the general pattern of karst groundwater flow was convergent, much divergence took place in the vadose zone by leakage from perched conduits into underlying fractures and partings. Overflow from both vadose and phreatic conduits into older, normally dry ones during floods was another cause for divergence of underground water. Dispersion of

contaminants was greatly enhanced in this way. (See also W89-04586) (Author's abstract)
W89-04589

WATER MOVEMENT AND STORAGE IN THE UNSATURATED ZONE OF A MATURELY KARSTIFIED CARBONATE AQUIFER, MENDIP HILLS, ENGLAND,
Bristol Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 2F.
W89-04590

SEASONAL, HYDROGEOLOGIC, AND LAND-USE CONTROLS ON NITRATE CONTAMINATION OF CARBONATE GROUND WATERS,
Pennsylvania State Univ., University Park.
J. R. Kastrinos, and W. B. White.
IN: Proceedings of the Environmental Problems in Karst Terranes and Their Solutions Conference. National Water Well Association, Dublin, OH. 1986. p 88-114, 11 fig, 3 tab, 40 ref.

Descriptors: *Path of pollutants, *Water pollution sources, *Karst hydrology, *Nonpoint pollution sources, *Agricultural chemicals, *Groundwater pollution, *Nitrates, *Land use, Aquifers, Seasonal variation, Agriculture, Urban hydrology, Flow pattern, Conduits, Chlorides, Sulfates, Manure, Road salt, Snow melt, Leaching.

The levels of nitrate, chloride, and sulfate were investigated in the carbonate aquifer of Central Pennsylvania. Water samples were collected from four diffuse-flow springs, four conduit-flow springs, and three surface streams biweekly for one year. Land-use distributions in the form of forested, agricultural, or urban areas were calculated for five drainage basins. Concentrations of nitrates and other species were generally more variable in the conduit-flow springs and surface waters than in the diffuse-flow springs. However, distinct seasonal cycles in nitrate concentration were not evident in any of the samples. Concentrations of nitrates were more strongly controlled by the nature of the flow and the residence time than by seasonal factors such as snow cover, growing season, and applications of manure. Nitrate concentrations increased linearly with fraction of land in agricultural use. The basin with the highest urban land-use also had comparatively high nitrate concentrations. High concentrations of chlorides were found in springs from urban basins with peaks in chloride corresponding to snow melt events suggesting that road salt was being flushed into shallow aquifers. Concentrations of all pollutants, particularly nitrates, were considerably higher in ground water samples than in the surface water samples. This implied that more pollutants were being leached into shallow aquifers than were reaching surface streams via overland flow. (See also W89-04586) (Author's abstract)
W89-04591

U.S. ENVIRONMENTAL PROTECTION AGENCY EMERGENCY RESPONSE TO TOXIC FUMES AND CONTAMINATED GROUND WATER IN KARST TOPOGRAPHY: BOWLING GREEN, KENTUCKY,
Environmental Protection Agency, Atlanta, GA. Region IV.
F. B. Stroud, J. Gilbert, G. W. Powell, N. C. Crawford, and M. J. Rigatti.
IN: Proceedings of the Environmental Problems in Karst Terranes and Their Solutions Conference. National Water Well Association, Dublin, OH. 1986. p 197-226, 18 fig, 7 ref.

Descriptors: *Groundwater pollution, *Aquifers, *Karst, *Path of pollutants, *Environmental protection, Hazardous materials, Toxins, Explosives, Kentucky, U.S. Environmental Protection Agency, Water pollution sources, Dye releases, Lost River Cave System, Geohydrology.

A preliminary report on the investigation of contaminated aquifers in karst topography in South Central Kentucky is presented. Hazardous chemicals have been introduced into cave systems in the Bowling Green, Kentucky area and have caused concerns over long-term health effects and explosions. In April 1985, solvent contamination and fumes in homes and public buildings initiated an emergency response action by U.S. EPA-Region IV. Dye tracing, cave exploration and mapping, exploratory drilling, geophysical studies, and unique sampling techniques have been used to locate contaminant pathways within the Lost River Cave System and to identify the source(s) of contamination and to mitigate their effects. The unique hydrogeology associated with karst terranes presents complex and distinct management problems. Rapid transport of contaminants through a karst system can significantly impact a groundwater supply within a short time. Leaking underground storage tanks and illegal dumping can add numerous point sources of contamination, thus making the evaluation of the overall impact of contamination especially problematic. (See also W89-04586) (Author's abstract)
W89-04596

GROUND WATER MONITORING CONSIDERATIONS IN KARST ON YOUNG LIMESTONES,
Florida Sinkhole Research Inst., Orlando.
B. F. Beck.
IN: Proceedings of the Environmental Problems in Karst Terranes and Their Solutions Conference. National Water Well Association, Dublin, OH. 1986. p 229-248, 9 fig, 41 ref.

Descriptors: *Monitoring, *Aquifers, *Karst, *Groundwater pollution, *Path of pollutants, *Groundwater movement, Flow pattern, Caves, Conduits, Monitoring wells, Permeability.

Ground water monitoring strategies must reflect the complex karst topography. In particular, where pollutants enter via a sinking stream, monitoring conduit flow may be critical. In other situations the presence of karst conduits may alter the expected direction of diffuse flow, and monitoring well placement must take this into account. However, in broad areas of diffuse flow, conventional monitoring network design may be appropriate, although dispersion will certainly be greater. The very low groundwater gradient characteristic of such high permeability terrains may permit pollutants to spread significant distances up gradient. Further, because of this very low gradient, it may be difficult to document the groundwater flow direction reliably from closely spaced wells, and monitoring wells may have to be separated by 1/4 to 1/2 mile to obtain consistent, unambiguous water levels. (See W89-04586) (Author's abstract)
W89-04597

USE OF FRACTURE TRACE ANALYSIS IN KARST TERRANES FOR ENVIRONMENTAL REMEDIAL ACTION PLANNING: A CASE STUDY,
Bionetics Corp., Warrenton, VA.
L. Mata, L. M. Fauss, and I. P. May.
IN: Proceedings of the Environmental Problems in Karst Terranes and Their Solutions Conference. National Water Well Association, Dublin, OH. 1986. p 263-277, 3 fig, 1 tab, 10 ref.

Descriptors: *Remote sensing, *Aerial photography, *Groundwater pollution, *Path of pollutants, *Karst, *Groundwater movement, *Geologic fractures, Flow pattern, Aerial photography, Geohydrology, Mapping.

Fracture trace and photogeologic analyses were used to characterize contaminated ground water flow in the karst terrane surrounding the Letterkenny Army Depot, Pennsylvania. Aerial photographs were analyzed to identify fracture trace features and differing rock units. Discrepancies were found between the location of the rock units as portrayed in the published regional geologic investigation and those rock unit locations identified through aerial photography and field work. The location of the dolomite rock unit, Pinesburg Station Formation, is especially important and has been mapped. The Pinesburg Station Formation dolomite forms small hills in the area and is believed to be a barrier to groundwater flow. The action of the Pinesburg Station Formation dolomite as a groundwater flow barrier was important for understanding the contaminant flow pattern. The Pinesburg Station Formation has been shattered due to fracturing and cross-faulting. A number of blocks of the formation are on the study area. Limestone solutionization was identified in the St. Paul Group along the contact between it and the Pinesburg Station Formation. Locations for geophysical testing in the study area were recommended. (See also W89-04586) (Hammond-PTT)
W89-04599

INORGANIC HYDROGEOCHEMISTRY OF THE DIXIE BEND LANDFILL IN PULASKI COUNTY, KENTUCKY,
Wright State Univ., Dayton, OH. Dept. of Geology.
P. Pushkar, J. P. Ferry, and R. H. Hoose.
IN: Proceedings of the Environmental Problems in Karst Terranes and Their Solutions Conference. National Water Well Association, Dublin, OH. 1986. p 278-308, 14 tab, 7 fig, 10 ref.

Descriptors: *Groundwater pollution, *Landfills, *Karst hydrology, *Geochemistry, *Water pollution sources, *Acid mine drainage, Waste disposal, *Path of pollutants, Hydrology, Effluents, Heavy metals, Anions, Caves.

The Dixie Bend Landfill near Sloans Valley, Pulaski County, Kentucky, began operations in 1981 to handle municipal wastes. Local residents began to fear that effluents from the landfill were contaminating their groundwater supply. Also at risk was the Sloans Valley Cave System. To test whether such contamination is occurring, hydrochemical surveys were conducted of local groundwaters, of three streams draining the landfill, and within the cave system. Three sets of samples collected over two years were analyzed for major cations and heavy metals (Na, Ca, Sr, Mg, Fe, Mn, Co, Ni, Pb, Cu, Cd, Zn). Samples from the streams were also analyzed for anions (SO4(--), Cl(-), F(-), NO3(-). The streams issuing from the landfill contain high concentrations of dissolved species and exceed EPA limits for Fe, Mn, Ca, Mg, and SO4(--). These high concentrations are lowered rapidly downstream, apparently by rises in Eh and pH and by dilution. Fe, Mn, and SO4(--), however, remain high; Fe and Mn exceed EPA recommendations in many local groundwaters. Although waters with high concentrations of many dissolved metals enter the Railroad Tunnel entrance of the cave system, these high concentrations drop off rapidly and concentrations throughout the cave system are generally low. Heavy metals which pose health and environmental hazards, such as Pb or Cd, only occasionally and temporarily exceed EPA limits and suggest derivation from small localized sources. The Dixie Bend is sited on an old coal strip mine. Low Cl(-) in the effluent suggests that much of the effluent may be due to acid mine drainage rather than the landfill. (See also W89-04586) (Author's abstract)
W89-04600

GROUND WATER PROBLEMS ASSOCIATED WITH A MUNICIPAL LANDFILL IN THE NASHVILLE DOME REGION OF ALABAMA,
Alabama Univ. in Huntsville. Civil Engineering Program.
K. M. Leonard, J. A. Gilbert, and W. F. Kane.
IN: Proceedings of the Environmental Problems in Karst Terranes and Their Solutions Conference. National Water Well Association, Dublin, OH. 1986. p 309-321, 6 fig, 2 tab, 8 ref, 1 append.

Descriptors: *Water pollution prevention, *Water pollution sources, *Landfills, *Groundwater pollution, *Path of pollutants, *Karst hydrology, *Alabama, Urban planning, Municipal wastes, Chemical oxygen demand, Hydrogen ion concentration, Tennessee River, Groundwater movement, Drinking water, Wells, Quarries, Surface runoff, Clays, Linings.

Data gathered from several government agencies on the Huntsville landfill show an upward trend in chloride levels and COD. The pH has been shown to be decreasing with time. These findings indicate

that pollution is reaching the aquifer to the south of the landfill site. The problem is compounded by the fact that the Huntsville landfill is situated in a karst area containing a large interconnected network of solution features. The section located in an abandoned quarry acts as a trap for surface runoff. The other section directs runoff towards nearby Spring Branch. This water makes its way to the Tennessee River which supplies potable water to Huntsville and other cities downstream. The testing interval required by the EPA (6 mo) for groundwater monitoring near Huntsville's landfill does not appear to be sufficient for this karst area. The large fluctuations in amounts of pollutants, coupled with the fact that a large amount of drinking water comes from wells in this area, underlines the need for more field research. If this site is to continue to be used for landfill, the use of a clay liner in the quarry, careful leveling of backfill to control runoff, and more frequent monitoring of wells should be considered. (See also W89-04586) (Hammond-PTT)
W89-04601

WATER TRACING USING A SCANNING SPECTROFLUOROMETER FOR DETECTION OF FLUORESCENT DYES,
Missouri Dept. of Natural Resources, Rolla. Div. of Geology and Land Survey.
For primary bibliographic entry see Field 7B.
W89-04606

GROUND WATER FLOW CHARACTERISTICS DESCRIBED BY QUANTITATIVE DYE TRACING IN KARST TERRANE IN THE ELIZABETHTOWN AREA, KENTUCKY,
Geological Survey, Louisville, KY.
D. S. Mull, and J. L. Smoot.
IN: Proceedings of the Environmental Problems in Karst Terranes and Their Solutions Conference. National Water Well Association, Dublin, OH. 1986. p 407-422, 14 fig, 8 ref.

Descriptors: *Groundwater pollution, *Path of pollutants, *Groundwater flow, *Tracers, *Karst, *Municipal water, Flow pattern, Dye releasers, Kentucky.

In an effort to provide a better understanding of the hydrologic system, particularly the recharge area of wells and springs used for public water supply, both qualitative and quantitative groundwater dye tracer studies were performed during a recent investigation in the Elizabethtown area, Hardin County, in north-central Kentucky. Qualitative dye tracing included the injection of a fluorescent dye into selected sinkholes or sinking streams and detection by passive detectors consisting of packets of activated coconut charcoal placed in suspected resurgences such as downgradient springs or discharges from pumped wells. All quantitative dye traces were made by injecting dye into a selected sinkhole and sampling for the dye at Dyers Spring, located about 3.5 miles southwest of Elizabethtown. The travel time, magnitude of the peak concentration, and time between selected points on the rising and falling limb of the dye response curve (residence time) generally vary with discharge. Therefore, repeat dye traces under different flow conditions are useful in developing a predictive capability. The information from these studies is especially useful to water managers who need to respond to the introduction of potential contaminants into the groundwater system. (See also W89-04586) (Hammond-PTT)
W89-04607

EFFECTS OF BRINE ON THE CHEMICAL QUALITY OF WATER IN PARTS OF CREEK, LINCOLN, OKFUSKEE, PAYNE, POTTAWATOMIE, AND SEMINOLE COUNTIES, OKLAHOMA,
Geological Survey, Norman, OK.
R. B. Morton.
Oklahoma Geological Survey, Norman. Circular 89, 1986. 38p, 10 fig, 5 tab, 1 plate, 38 ref, 3 append.

Descriptors: *Saline water intrusion, *Brine, *Water quality, *Groundwater pollution, *Oklahoma, Aquifers, Sodium, Chlorides, Bromide, Lithium, Strontium, Dissolved solids, Calcium, Magnesium, Sulfates, Chemical analysis, Geochemistry.

A study of water quality degradation due to brine contamination was made in an area of about 1,700 sq mi in east-central Oklahoma. The study area coincides in part with the outcrop of the Vamoosa-Ada aquifer of Pennsylvanian age. Water samples collected from 180 wells completed in the Vamoosa-Ada aquifer and at 167 sites from streams draining the Vamoosa-Ada aquifer show scattered occurrences of water quality degradation by brine. Degradation of water quality by brine is indicated where: (1) chloride concentration is > or = to 400 mg/L; (2) bromide concentration is > or = 2 mg/L; (3) the ratio of sodium plus chloride to dissolved solids is > or = 0.64. Ratios of secondary importance that also indicate water quality degradation by brine in the area are: (1) a ratio of lithium to bromide < or = 0.01, when the chloride concentration is > or = 400 mg/L; (2) a sodium/chloride ratio of about 0.46; (3) a sodium/bromide ratio of about 92; and (4) a bromide/chloride ratio of about 0.0048. Values for bromide, lithium, strontium, dissolved solids, calcium, magnesium, sodium, chloride, and sulfate concentrations were subjected to analysis of variance based on use of the index values in partition data sets. The analysis of variance showed the significance of the indexes for all constituents except sulfate. The two most reliable brine indicators are chloride and bromide. Statistically, chloride is a slightly more reliable index than bromide. The developed indexes can be used to indicate water quality degradation by brine. Accuracy is improved if both indexes are used. When geophysical logs from 133 pairs of oil and gas wells were analyzed, data from 5 pairs of wells indicated a possible rise in the interface between fresh water and salt water in the Vamoosa-Ada aquifer. Therefore, any rise of the interface is local rather than regional. The criteria developed in this study indicate that brine has degraded water quality at 63 sites on streams draining the Vamoosa-Ada aquifer, at 15 water wells completed in the Vamoosa-Ada aquifer, and at 5 oil and gas wells penetrating the Vamoosa-Ada aquifer. (Author's abstract)
W89-04614

HYDROGEOLOGY AND GEOCHEMISTRY OF THE UNCONFINED AQUIFER, WEST-CENTRAL AND SOUTHWESTERN DELAWARE,
Delaware Geological Survey, Newark.
For primary bibliographic entry see Field 2F.
W89-04618

1985 WATER QUALITY MONITORING RIVERS AND STREAMS.
Indiana Dept. of Environmental Management, Indianapolis. Office of Water Management.
Indiana Dept. of Environmental Management, Office of Water Management, 1985. 141p, 6 tab.

Descriptors: *Water quality data, *Monitoring, *Indiana, *Surface waters, *Data collections, Rivers, Surface waters, Water quality management, Streams, Public health, Chemical analysis, Physical analysis, Microbiological studies.

This is the 27th annual water quality report on the major surface waters of Indiana. In April 1957, the Division of Sanitary Engineering, Indiana State Board of Health, established 49 sites for the biweekly collection of samples for physical, chemical, and bacteriological analyses, and 10 of the stations were sampled for radiological analyses. Various changes and improvements have been made since the program was established in 1957. On April 1, 1986, the Indiana Department of Environmental Management assumed this program's duties. At the time, 94 stations were included in the 1985 program. Physical, chemical, and bacteriological analyses are made on samples collected from all 94 of these stations, plankton analyses from 18, and radiological analyses from 23. Data are presented in tabular form. Levels of radioactivity in Indiana watercourses averaged well under recognized acceptable guides. (Lantz-PTT)
W89-04625

ESTIMATED AVERAGE ANNUAL ALKALINITY OF SIX STREAMS ENTERING DEEP CREEK LAKE GARRETT COUNTY, MARYLAND,
Geological Survey, Dover, DE.
A. L. Hodges.
Maryland Power Plant Siting Program, Dover, Delaware, April 1986. 63p, 5 fig, 7 tab, 20 ref. Maryland Power Plant Siting Program Contract P2-MGS-283.

Descriptors: *Acid rain effects, *Water quality, *Alkalinity, Deep Creek Lake, *Maryland, *Water pollution sources, *Acid mine drainage, Streams, Carbonates, Bedrock, Silicates, Deep Creek Lake.

Deep Creek Lake in Garrett County, Maryland, drains an area of about 65 sq mi. There is concern that acid rain combined with acid mine drainage from coal mining in the basin will exceed the capacity of the lake to buffer the acid input from these sources. This study was done during 1983 to determine the sources of alkalinity to the lake, and to make a rough estimate of the amount of alkalinity that enters the lake from six streams that drain carbonate and noncarbonate bedrock formations. Bedrock in the basin is predominantly sandstone and shale of Devonian to Pennsylvanian age. The Mississippian Greenbrier Formation, which crops out in 5% of the basin, is the only calcareous rock unit. Four streams draining the Greenbrier and two streams draining noncarbonate formations were sampled to assess the contribution of alkalinity to Deep Creek Lake. The average annual alkalinity of six sampled streams ranged from 7.6 to 36.8 tons/yr/sq mi of drainage area. The average total alkalinity contributed to Deep Creek Lake by these streams is 161 tons/yr as calcium carbonate. Mass-balance calculations based on very limited data indicate that this alkalinity is derived from both carbonate rocks (Greenbrier Formation) and from weathering and hydrolysis of silicate minerals. Other sources may contribute alkalinity to Deep Creek Lake, but could not be quantified within the scope of this study. No changes in stream-water quality were found that could be directly attributed to the stream having crossed the boundary from one noncarbonate bedrock formation to another. Inflow to streams from adjacent or underlying carbonate bedrock was apparent in several streams from increased values of pH and conductance. (Author's abstract)
W89-04630

PHYSICAL AND CHEMICAL CHARACTERISTICS OF WATER IN COAL-MINE PONDS, EASTERN OKLAHOMA, JUNE TO NOVEMBER 1977-81,
Geological Survey, Oklahoma City, OK. Water Resources Div.
For primary bibliographic entry see Field 5A.
W89-04647

EFFECTS OF LAND USE ON DISCHARGE AND WATER QUALITY IN NEWAUKUM CREEK BASIN, KING COUNTY, WASHINGTON,
Geological Survey, Tacoma, WA. Water Resources Div.
For primary bibliographic entry see Field 4C.
W89-04648

SIMULATION OF GROUND-WATER MOVEMENT IN THE '1,500- AND 1,700-FOOT' AQUIFER OF THE BATON ROUGE AREA, LOUISIANA,
Geological Survey, Baton Rouge, LA. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-04655

LIMNOLOGICAL STUDY OF LAKE BRUIN, LOUISIANA,
Geological Survey, Baton Rouge, LA. Water Resources Div.
For primary bibliographic entry see Field 2H.
W89-04660

COMPARISON BETWEEN BULK AND WET PRECIPITATION IN THE LUQUILLO RAIN FOREST,
Center for Energy and Environment Research, San Juan, PR.
For primary bibliographic entry see Field 2K.
W89-04671

ACIDITY OF RAIN IN PUERTO RICO,
Puerto Rico Univ., Mayaguez.
For primary bibliographic entry see Field 2B.
W89-04675

ESTIMATES OF FRESHWATER PRODUCTION FROM COASTAL AQUIFERS USING AREA OF DIVERSION OF WELL FIELDS AND AREAL DISTRIBUTION OF CHLORIDE CONCENTRATIONS,
Geological Survey, Tuscaloosa, AL. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-04680

SIMULATION OF THE FLOW SYSTEM IN THE SHALLOW AQUIFER, DAUPHIN ISLAND, ALABAMA,
Geological Survey, Tuscaloosa, AL. Water Resources Div.
R. E. Kidd.
IN: Third Caribbean Islands Water Resources Congress. Proceedings of a Symposium held in St. Thomas, U.S. Virgin Islands, July 22-25, 1986. p 87-90, 2 fig, 6 ref.

Descriptors: *Groundwater movement, *Path of pollutants, *Simulation analysis, *Aquifers, *Dauphin Island, *Alabama, *Saline water intrusion, Chlorides, Iron, Dissolved solids, Wells, Drinking water, Groundwater quality, Potable water, Model studies, Hydraulic conductivity, Water demand, Pumping.

The development of freshwater aquifers on Dauphin Island, Alabama, for industrial and domestic supplies is threatened by salt-water encroachment. The surficial aquifer is the only source of potable water with a chloride concentration below the maximum contaminant level recommended in the National Drinking Water Regulations. A two-dimensional finite-difference model of the water table aquifer was used to evaluate the flow system. The parameters used in the model are: aquifer hydraulic conductivity, aquifer thickness, recharge to the aquifer, and the vertical hydraulic connection between the aquifer and the surrounding surface water bodies. The hydraulic conductivity of the aquifer was determined from aquifer tests of 2 and 30 days duration. The calibrated steady-state model was used to develop a transient model to define the specific yield of the aquifer. The average water demand on the island is about 0.2 million gallons per day (Mgal/d). Aquifer tests indicate that 50 gallons per minute (gpm) could be obtained from wells in the water table aquifer. Pumpage schemes with eight wells pumping a total of 0 .3 Mgal/d (200 gpm) and 0.6 Mgal/d (400 gpm) were simulated with both steady-state and transient models. The evaluations were considered successful if a groundwater divide was maintained between the pumping center and the salt water bodies surrounding the island. Steady-state simulation of pumping at 0.3 Mgal/d produced water levels of about 1 to 2 ft above sea level at each of the eight wells. Increasing pumpage to 0.6 Mgal/d produced water levels of about 2 to 3 ft below sea level at each well. Transient model simulation of 0.3 Mgal/d pumpage created water levels of 1 to 2 ft above sea level. Pumpage of 0.6 Mgal/d created water levels from about 2.5 to near 4 ft below sea level. The simulated pumping schemes indicate the water table aquifer could yield 0.6 Mgal/d without lateral encroachment with recharge less than 10-yr average minimum. All of the schemes maintained a groundwater divide between the wells and the surrounding salt water bodies. (See also W89-04665) (Lantz-PTT)
W89-04681

HUMIC LAKES: ACIDITY FROM NATURAL AND ANTHROPOGENIC SOURCES,
National Board of Waters, Helsinki (Finland).
For primary bibliographic entry see Field 2H.
W89-04729

WATER QUALITY OF PEATLANDS AND MAN'S INFLUENCE ON IT,
Tampere Water and Environmental District (Finland).
T. Sallantaus.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu, Finland. 6-8 June 1988. Vol. 2. The Academy of Finland, Helsinki, Finland. 1988. p 80-98, 4 fig, 44 ref.

Descriptors: *Peat bogs, *Water quality, *Runoff, *Leaching, *Drainage effects, *Wetlands, *Water pollution sources, Clear-cutting, Organic carbon, Hydrogen ion concentration, Infiltration, Environmental effects, Water pollution sources, Vegetation effects, Ecological effects, Organic matter.

Peatlands affect the runoff water quality by (1) accumulating elements, thereby reducing leaching potential, (2) insulating surface waters from reaching mineral soils, thereby potentially reducing the leaching of weathering products but increasing the leaching of organic carbon and airborne elements not retained by peat, (3) increasing the leaching potential of such elements, the dissolution of which is greatly enhanced by complexation with organic matter, reduced pH, or reduced redox potential created by the peat. Drainage and utilization alter the processes operating in natural peatland ecosystems; accumulation ceases, decomposition increases, infiltration and deep runoff increase, minerogenic peatlands become ombrogenic due to surrounding ditches, redox potentials in the surface layer increase. The response of different peatlands to drainage is likely to be diverse; e.g. both the neutralization and acidification of runoff waters, and an increase and decrease in dissolved organic matter leaching are theoretically possible and some support for each case can even be found from the available scanty research data. (See also W89-04731) (Author's abstract)
W89-04742

EFFECT OF PEAT PRODUCTION ON WATER QUALITY AND BACTERIOPLANKTON IN THE DRAINAGE BASIN OF THE RIVER KII-MINKIJOKI,
Oulu Univ. (Finland). Dept. of Botany.
For primary bibliographic entry see Field 2H.
W89-04743

COMPREHENSIVE SAMPLING PROGRAM FOR THE Y-12 PLANT AREA SOURCE POLLUTION ASSESSMENT AND CONTROL PLAN,
Oak Ridge Y-12 Plant, TN.
R. H. Kingrea, E. F. Arniella, L. A. Roesner, and T. Quasebarth.
Available from the National Technical Information Service, Springfield, VA 22161, as DE88-001817. Price codes: A03 in paper copy, A01 in microfiche. October 1987. 15p, 5 fig, 2 tab. Contract DE-AC05-840821400.

Descriptors: *Network design, *Model studies, *Water pollution sources, *Water sampling, Nonpoint pollution sources, RUNOFF model, Oak Ridge Y-12 Plant, East Fork Poplar Creek, Tennessee, Monitoring.

A method was developed to implement a comprehensive sampling program of the East Fork Poplar Creek drainage area in Oak Ridge, TN, in order to establish the best management practices for the contol of nonpoint pollution sources in the drainage area is presented. A key element of the control plan is the development of the RUNOFF model which requires data on the physical characteristics of the watershed and the network of channels, pipes, and/or lakes that drain the area. This model has been calibrated with existing information and with data collected in the preliminary program. The model was used to analyze surface runoff and pollutant transport, and to locate the permanent sampling stations in strategic locations so as to provide the maximum amount of useful data. Major equipment needed includes 11 automatic samplers, 11 flow plotters, and 2 rain gages. The data obtained will be used to fine-tune the model, to define pollution sources, to predict the impact of source control, and to simulate extreme hydraulic and pollutant loading conditions in the drainage area. (White-Reimer-PTT)
W89-04745

EFFECT OF ENVIRONMENTAL VARIABLES ON ENTERIC VIRUS SURVIVAL IN SURFACE FRESHWATERS,
Health Effects Research Lab., Cincinnati, OH.
C. J. Hurst.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-125687. Price codes: A03 in paper copy, A01 in microfiche. Report No. EPA/600/D-87/321, October 1987. 7p, 2 fig, 2 tab, 6 ref.

Descriptors: *Public health, *Literature reviews, *Water quality, *Viruses, Enteroviruses, Enterovirus survival, Wastewater pollution, Ultraviolet radiation, Temperature effects, Hardness, Hydrogen ion concentration, Chlorides, Organic carbon, Microorganisms.

In a review of published studies concerning the stability of enteric viruses in surface freshwaters, those environmental variables which have been determined to have a statistically significant effect are pH, chloride, TOC, hardness, turbidity, and exposure to sunlight when in shallow trays. It was demonstrated by regression analysis that temperature was also a statistically significant factor. The rates at which inactivation of enteroviruses and rotaviruses varied in response to temperature were clearly different, with rotaviruses appearing to be much more stable as a group in surface freshwaters. Other factors which have been cited as having a demonstrable effect upon enteric virus stability in these types of waters are aerobic microorganisms, undetermined volatile or heat labile factors intrinsic to the natural water samples, nonseasonal factors intrinsic to the natural water samples, and sewage pollution in the case of at least human echovirus type 7. It was also found that high turbidity in water samples can reduce the inactivating effect of sunlight. (Author's abstract)
W89-04746

SUPERFUND RECORD OF DECISION: MINKER STOUT/ROMAINE CREEK, MO.
For primary bibliographic entry see Field 5G.
W89-04750

METALS IN COASTAL ENVIRONMENTS OF LATIN AMERICA.
For primary bibliographic entry see Field 5A.
W89-04755

HEAVY METALS SURVEYS IN BRAZILIAN COASTAL ENVIRONMENTS,
Universidade Federal do Rio de Janeiro (Brazil). Inst. de Biofisica.
For primary bibliographic entry see Field 5A.
W89-04756

HEAVY METALS IN WATER AND SEDIMENTS OF THE BLANCA BAY, ARGENTINA,
Instituto Argentino de Oceanografia, Buenos Aires.
A. E. Pucci.
IN: Metals in Coastal Environments of Latin America. Springer-Verlag, New York. 1988. p 9-15, 4 fig, 4 tab, 16 ref.

Descriptors: *Water pollution sources, *Pollutant identification, *Metals, *Argentina, *Heavy metals, *Sediments, Copper, Cadmium, Zinc, Iron, Manganese, Blanca Bay, Coastal waters, Runoff.

The metal distribution in superficial sediments of the Blanca Bay seems to be influenced by local effluents and the water circulation pattern of the Bay. Water and superficial sediment samples col-

lected from six stations and analyzed for metal concentrations indicated total and dissolved metal concentrations in the waters of Blanca Bay were higher than those of adjacent Atlantic Ocean waters but were close to values reported for similar coastal water bodies. Anthropogenic effluents seem to be the main source of metals to the Blanca Bay although during the rainy season in autumn and early winter, runoff from the watershed may be of additional importance. (See also W89-04755) (White-Reimer-PTT)
W89-04757

PRELIMINARY SURVEY OF HEAVY METAL CONCENTRATIONS IN SOME ESTUARINE ORGANISMS IN THE LITTORAL ZONE OF SAO LUIS ISLAND, MARANHAO, BRAZIL,
Universidade Federal do Maranhao, Sao Luis (Brazil). Lab. de Hidrobiologia.
A. A. Juras.
IN: Metals in Coastal Environments of Latin America. Springer-Verlag, New York. 1988. p 18-20, 1 fig, 1 tab, 13 ref.

Descriptors: *Brazil, *Tissue analysis, *Water pollution sources, *Metals, *Heavy metals, *Estuaries, *Estuarine environment, Mercury, Lead, Copper, Zinc, Mussels, Fish, Sao Luis Island, Masranhao, Industrial wastes, Atomic absorption spectroscopy.

Samples of mussels and fishes were taken during the dry season from Mosquito and Coqueiro Straits close to the ALCOA factory and analyzed for mercury, lead, copper and zinc by atomic absorption spectrophotometry. The results indicate that concentrations of heavy metals vary in relation to the organism analysed. The concentration of mercury ranged from 0.02 to 0.03 ppm in mussels and from 0.02 to 0.28 ppm in fish. However, the mussels and fishes of Sao Luis Island do not appear to reflect serious heavy metal contamination in their surrounding waters. (See also W89-04755) (White-Reimer-PTT)
W89-04758

STUDY OF HEAVY METAL POLLUTION IN THE TRIBUTARY RIVERS OF THE JACAREPAGUA LAGOON, RIO DE JANEIRO STATE, BRAZIL, THROUGH SEDIMENT ANALYSIS,
Comissao Nacional de Energia Nuclear de Brasil, Rio de Janeiro. Inst. de Radioproteccao e Dosimetria.
For primary bibliographic entry see Field 5A.
W89-04759

SPATIAL DISTRIBUTION OF HEAVY METALS IN SEAWATER AND SEDIMENTS FROM COASTAL AREAS OF THE SOUTHEASTERN BUENOS AIRES PROVINCE, ARGENTINA,
Instituto Argentino de Oceanografia, Buenos Aires. Lab. de Quimica Marina.
For primary bibliographic entry see Field 5A.
W89-04760

GEOCHEMICAL AND STATISTICAL APPROACH FOR ASSESSING METAL POLLUTION IN COASTAL SEDIMENTS,
Florida State Dept. of Environmental Regulation, Tallahassee.
For primary bibliographic entry see Field 5A.
W89-04761

TRACE METAL DISTRIBUTION IN SEDIMENTS OF THE PATOS LAGOON ESTUARY, BRAZIL,
Fundacao Univ., Rio Grande (Brazil).
For primary bibliographic entry see Field 5A.
W89-04762

ATMOSPHERIC LEAD DEPOSITION INTO GUARAPINA LAGOON, RIO DE JANEIRO STATE, BRAZIL,
Universidade Federal Fluminense, Niteroi (Brazil). Dept. de Geoquimica.
For primary bibliographic entry see Field 5A.
W89-04763

METAL ION CONCENTRATION IN SEDIMENTS FROM HELLSHIRE, A JAMAICAN COASTAL ENVIRONMENT,
University of the West Indies, Kingston (Jamaica). Dept. of Chemistry.
A. M. Greenaway, R. J. Lancashire, and A. I. Rankine.
IN: Metals in Coastal Environments of Latin America. Springer-Verlag, New York. 1988. p 77-85, 1 fig, 3 tab, 15 ref.

Descriptors: *Path of pollutants, *Chemical analysis, *Metals, *Heavy metals, *Sediments, *Jamaica, *Coastal waters, Estuaries, Aluminum, Calcium, Manganese, Titanium, Vanadium, Europium, Dysprosium, Magnesium, Strontium, Barium, Hellshire, Sediment transport, Neutron Activation analysis.

Twenty of 20 sediment samples were collected during two sampling trips and analysed for Al, Ca, Mn, Ti, V, Eu, Dy, Mg, Sr, and Ba using Instrumental Neutron Activation Analysis. From the appearance of the sediments and the Ca analytical data it can be inferred that the bulk of the sediments were calcium carbonate. The lower Ca and higher Al concentrations found at the harbor mouth were presumably due to these sediments being composed of coastal and harbor sediments. The data indicate that harbor sediments are being transported along the coast, but once away from the harbor mouth, they quickly disperse. The build up in trace element concentrations towards the western side of the harbor mouth suggests that sediment transport from the harbor is mainly via that side of the mouth. The data also suggest that Al, V, Dy, Eu, Ti, Ba, Mn, and Mg are entering the coastal area from the harbor and the Salt Pond, and that the sediments originating from the coastal area are calcium carbonates containing Sr. (See also W89-04755) (White-Reimer-PTT)
W89-04764

GEOCHEMICAL DISTRIBUTION OF CD, CU, CR AND PB IN SEDIMENTS OF ESTUARINE AREAS ALONG THE SOUTHEASTERN BRAZILIAN COAST,
Universidade Federal Fluminense, Niteroi (Brazil). Dept. de Geoquimica.
L. D. Lacerda, C. M. M. Souza, and M. H. D. Pestana.
IN: Metals in Coastal Environments of Latin America. Springer-Verlag, New York. 1988. p 86-99, 7 fig, 2 tab, 19 ref.

Descriptors: *Pollutant identification, *Path of pollutants, *Brazil, *Metals, *Heavy metals, *Sediments, *Estuaries, Geochemistry, Coastal waters, Cadmium, Copper, Chromium, Lead, Rio de Janeiro State, Bioavailability, Marine sediments.

Sequential extraction techniques were used to evaluate metal availability and potential risk in sediments of seven estuaries along the coast of Rio de Janeiro State, under various levels of metal contamination and different ecological conditions. In the polluted areas all metals except Pb, showed a wide range of forms. Geochemical partitioning of metals in contaminated estuarine sediments reflects the major influences of anthropogenic activities upon metal fate. The results show that more diverse geochemical metal forms occur in more contaminated river systems with oxidizable forms important under naturally eutrophic conditions resulting in a synergistic interaction between organic and metal contamination. The dissociation of the reduced forms in the oxidized sediments releases the metals to the water column and may result in an increase in the biological availability of metals and enhance metal toxicity. The dilution effect resulting from the mixture of river and marine sediments could only be detected for Cu and Cd in the non-contaminated areas. (See also W89-04755) (White-Reimer-PTT)
W89-04765

BEHAVIOUR OF POLLUTANT METALS IN AQUATIC SEDIMENTS,
Universidade Federal Fluminense, Niteroi (Brazil). Dept. de Geoquimica.
For primary bibliographic entry see Field 5A.
W89-04766

FATE OF METALS IN BIOTA AND BIOLOGICAL INTERACTIONS IN THE TROPICAL COASTAL ZONE,
Newcastle upon Tyne Univ. (England). Dept. of Zoology.
B. E. Brown.
IN: Metals in Coastal Environments of Latin America. Springer-Verlag, New York. 1988. p 109-121, 3 fig, 5 tab, 45 ref.

Descriptors: *Fate of pollutants, *Path of pollutants, *Metals, *Heavy metals, *Coastal waters, *Bioaccumulation, Sediments, Food chains, Seagrasses, Mangroves, Coral reefs, Tropical regions, Water pollution sources.

In tropical coastal waters clear interactions between the three major habitats, seagrasses, mangroves and coral reefs with animal migration between all three and transport of detrital material from seagrass beds to deeper reef habitats are recognized. The most important sources of heavy metals in the tropical marine environment have been cited as the result of mining and dredging operations, smelting processes, offshore oil drilling, desalination plant effluents, thermal power plant effluents, bauxite mining and sewage discharge. Biological research programs studying tropical coastal environments should include an identification of sensitive habitats and potentially contaminated sites, measurement of metals in 'indicator' organisms, bioassays to evaluate the effects of heavy metals, and monitoring more broadscale effects of metallic pollution in the field. (See also W89-04755) (White-Reimer-PTT)
W89-04767

TOTAL MERCURY LEVELS IN MARINE ORGANISMS OF THE BAHIA BLANCA ESTUARINE TROPHIC WEB,
Instituto Nacional de Investigacion y Desarrollo Pesquero, Mar del Plata (Argentina).
For primary bibliographic entry see Field 5A.
W89-04768

UPTAKE OF ZN AND CD BY COASTAL PHYTOPLANKTON SPECIES IN CULTURE,
Institut National de la Sante et de la Recherche Medicale, Paris (France).
C. S. Karez, M. Romeo, and M. Gnassia-Barelli.
IN: Metals in Coastal Environments of Latin America. Springer-Verlag, New York. 1988. p 130-139, 4 fig, 2 tab, 22 ref. CNRS contract AIP 1335.

Descriptors: *Path of pollutants, *Bioaccumulaiton, *Metals, *Heavy metals, *Zinc, *Cadmium, *Phytoplankton, *Culturing techniques, Cultures, Coastal waters, Hymenomonas elongata.

A coastal phytoplankton species (Hymenomonas elongata) was studied at different stages of growth for zinc uptake as well as zinc and cadmium interactions. A significant accumulation of zinc was observed in comparison with the controls in all the experiments, with accumulation increasing as a function of exposure time. Under the chosen conditions (low nutrient concentration in the medium and 150NgZn/L) no apparent toxic effect on cell division was observed. The maximum accumulation was observed from day 10 to day 12. A decreased uptake in the dark was more significant for exponentially growing cells than for cells in the stationary phase. Rinsing contaminated cells with EDTA desorbed almost 100% of the zinc taken up by exponentially growing cells, whereas only 40% of the accumulated zinc was removed from cells exposed for 24 hr. Cadmium uptake by exponentially growing cells was a function of exposure time and deceased when the experiments were conducted in the dark. The antagonistic effect observed for the uptake of a zinc-cadmium mixture may be due to competition between the two metals for adsorption sites on cell surfaces. (See also W89-04755) (White-Reimer-PTT)
W89-04769

TOTAL MERCURY, CADMIUM AND LEAD DISTRIBUTION IN TISSUES OF THE SOUTHERN SEA LION (OTARIA FLAVESCENS) IN THE ECOSYSTEM OF MAR DEL PLATA, ARGENTINA,
Instituto Nacional de Investigacion y Desarrollo Pesquero, Mar del Plata (Argentina).
For primary bibliographic entry see Field 5A.
W89-04770

LABORATORY EXPERIMENTS ON CO60 BIOACCUMULATION BY TROPICAL SEAWEEDS,
Universidade Federal do Rio de Janeiro (Brazil). Inst. de Biofisica.
For primary bibliographic entry see Field 5A.
W89-04771

BEHAVIOUR AND IMPACT ASSESSMENT OF HEAVY METALS IN ESTUARINE AND COASTAL ZONES,
Institute for Soil Fertility, Haren (Netherlands).
W. Salomons, H. Kerdijk, H. van Pagee, R. Klomp, and A. Schreur.
IN: Metals in Coastal Environments of Latin America. Springer-Verlag, New York. 1988. p 157-198, 27 fig, 3 tab, 83 ref.

Descriptors: *Path of pollutants, *Metals, *Heavy metals, *Sediments, *Coastal waters, *Model studies, Bioavailability, Chemical reactions, North Sea, Estuaries, Rivers.

A number of processes which affect the occurrence of heavy metals in fluvial, estuarine and coastal environments are described. Abiotic reservoirs of metals include deposited sediments, interstitial water, suspended matter, and surface water. The contribution of the heavy metal burden to the aquatic organisms depends on bioavailability and on habitat. In order to assess the pollution caused by heavy metals for a given region three different methods often used are: (1) sediment analysis, (2) bioassays, and (3) modelling. Sediment analysis methods include; mechanical separation of a grain size fraction and analysis for heavy metals, extrapolation from regression curves, correction for inert mineral constituents, and comparison with 'conservative' elements. If data on water and sediment movement are available, modelling is able to give an integrated view on the distribution of metals. A prerequisite is the availability of the hydrodynamic conditions in a given area in order to model the water movement. Modelling of the input of trace metals into the North Sea by the North Atlantic, the English channel, the atmosphere, various rivers (Rhine, Meuse, Ems, and Scheldt) and the English and Dutch coasts is illustrated. (See also W89-04755) (White-Reimer-PTT)
W89-04772

METALS CYCLES IN COASTAL ENVIRONMENTS,
Kiel Univ. (Germany, F.R.). Inst. fuer Meereskunde.
K. Kremling.
IN: Metals in Coastal Environments of Latin America. Springer-Verlag, New York. 1988. p 199-214, 8 fig, 53 ref.

Descriptors: *Path of pollutants, *Metals, *Heavy metals, *Trace metals, *Hydrologic cycle, *Coastal waters, Mass-balance, Benthic fluxes, Particle interactions, Chemical speciation.

The transport of chemical elements to the ocean is primarily influenced by river inputs, atmospheric depositions and hydrothermal activities. Mass-balances are concerned with fluxes into and out of the water column, and may be constructed for the entire world ocean or for regional and marginal seas. The most crucial point for the success of mass-balances are the data on influxes and effluxes. Major processes potentially affecting trace metal recycling in coastal zones include seasonal changes in the composition of surface waters, benthic fluxes, particle interactions, and chemical speciation. The potential role of biological processes in the speciation and cycling of elements in the coastal environments is illustrated. Evidence indicates the 'depleted' and 'unchanged' elements exhibit a strong affinity for the solid phase making it unlikely that high solution values will be sustained during their transport through the coastal regions. Therefore, man's influence will be most strongly felt in the coastal environments were the mean residence times are relatively short. (See also W89-04755) (White-Reimer-PTT)
W89-04773

MINERALOGICAL CONTROL OF HEAVY METAL BEHAVIOUR IN COASTAL ENVIRONMENTS: COPPER IN RIBEIRA BAY, RIO DE JANEIRO, BRAZIL,
Universidade Federal Fluminense, Niteroi (Brazil). Dept. de Geoquimica.
E. D. Bidone, and E. V. Silva Filho.
IN: Metals in Coastal Environments of Latin America. Springer-Verlag, New York. 1988. p 215-221, 2 fig, 2 tab, 6 ref.

Descriptors: *Path of pollutants, *Metals, *Heavy metals, *Copper, *Coastal waters, *Sediments, Estuaries, Geohydrology, Sediment minerology, Ribeira Bay, Rio de Janeiro, Brazil.

Composite, grab, and suspended sediment samples were collected in Ribeira Bay, Brazil, and analyzed for copper using x-ray fluorescence. Copper concentrations ranged from a mean of 64 ppm in downstream estuarine sediments to 3.8 ppm in open water sediments. This wide variation of copper concentrations in the study area means that citing one baseline value is misleading for pollution studies in this region and possibly other regions. The distribution pattern presented by copper is due to (1) total breakdown of the amorphous iron hydroxides and partial breakdown of crystalline iron hydroxides in the estuary and inlet, (2) the biotite accumulation in the estuary and its dispersion towards open water, (3) the absence of neoformation of sulfide forms due to the low residence time of organic matter in the estuary and inlet and hydrodynamic dispersion towards the open water where organic matter oxidation occurs, and (4) the increased sand in the open waters which implies that copper-carrying minerals are diluted by quartz grains with neglible copper content. (See also W89-04755) (White-Reimer-PTT)
W89-04774

TECHNETIUM IN COASTAL ENVIRONMENTS: FIELD OBSERVATIONS AND LABORATORY EXPERIMENTS,
Centre d'Etude de l'Energie Nucleaire, Mol (Belgium). Dept. de Biologie.
S. Bonotto, D. van der Ben, F. Capot, J. M. Bouquegneau, and M. Cogneau.
IN: Metals in Coastal Environments of Latin America. Springer-Verlag, New York. 1988. p 222-236, 3 fig, 6 tab, 65 ref. Contract CCE BIO-B-485-82-B.

Descriptors: *Path of pollutants, *Metals, *Heavy metals, *Technetium, *Coastal waters, *Radioactive wastes, Bacteria, Fish, Algae, Annelids, Crustaceans, Food chains, Bioaccumulation.

Technetium is an artificial element with the properties of a metal, discovered by irradiating molybdenum. Technetium may enter the environment by means of nuclear weapon tests, nuclear power plants, nuclear fuel reprocessing, nuclear waste storage, and pharmaceutical use. The distribution and chemical forms of technetium in marine organisms were measured using a variety of techniques. Results obtained reveal a wide range of technetium concentration factors among uni- and multicellular organisms. Technetium is poorly concentrated by many marine organisms. However, some algae, crustaceans, mollusks, and worms consistently accumulate technetium to a high degree. Because of its high variability, the concentration factor is considered the largest contributor to uncertainties in aquatic food web models employed to assess the impact of radioactive releases. Although direct consumption of contaminated seafood would result in direct ingestion of technetium, the accumulation of this element in edible muscle tissues is rather low. The transfer of technetium through marine food webs does not seem to constitute a critical pathway leading to the internal contamination of human populations; however, some uncertainties remain. (See also W89-04755) (White-Reimer-PTT)
W89-04775

METAL MONITORING IN COASTAL ENVIRONMENTS,
Uppsala Univ. (Sweden). Dept. of Hydrology.
For primary bibliographic entry see Field 5A.
W89-04776

MULTISPECIES METAL MONITORING IN TROPICAL BRAZILIAN ESTUARIES,
Fundacao Univ., Rio Grande (Brazil). Dept. of Oceanography.
For primary bibliographic entry see Field 5A.
W89-04777

EICHHORNIA CRASSIPES AS A BIOLOGICAL MONITOR OF HEAVY METALS IN SURFACE WATERS,
Universidade Federal Fluminense, Niteroi (Brazil). Dept. de Geoquimica.
For primary bibliographic entry see Field 5A.
W89-04779

STRATEGIES FOR BIOLOGICAL MONITORING: THE EUROPEAN EXPERIENCE,
King's Coll., London (England). Monitoring and Assessment Research Centre.
For primary bibliographic entry see Field 5A.
W89-04780

METALS IN COASTAL ENVIRONMENTS OF LATIN AMERICA: RECOMMENDATIONS FOR A CRITICAL SITUATION,
Fundacao Univ., Rio Grande (Brazil). Dept. of Oceanography.
For primary bibliographic entry see Field 5A.
W89-04781

EFFECTS OF SEWAGE SLUDGE ON LEACHATES AND GAS FROM SLUDGE-REFUSE LANDFILLS,
Environmental Protection Agency, Cincinnati, OH. Water Engineering Research Lab.
For primary bibliographic entry see Field 5E.
W89-04812

METHODS FOR EVALUATING SOLIDIFIED WASTE,
Alberta Environmental Centre, Vegreville.
For primary bibliographic entry see Field 5A.
W89-04820

QUALITY ASSURANCE ON THE GROUNDWATER MONITORING TASK FORCE FACILITY ASSESSMENT PROGRAM,
Life Systems, Inc., Cleveland, OH.
For primary bibliographic entry see Field 5A.
W89-04824

STATEWIDE SURVEY OF AQUATIC ECOSYSTEM CHEMISTRY: 1985,
California State Dept. of Fish and Game, Rancho Cordova. Water Pollution Control Lab.
K. McCleneghan, J. L. Nelson, J. T. King, and S. J. Baumgartner.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-124995. Price codes: A03 in paper copy, A01 in microfiche. Laboratory Report No. 85-5, December 1985. 60p, 4 fig, 12 tab, 28 ref, 5 append. State of California Air Resources Board Contract A3-107-32.

Descriptors: *Water analysis, *Acid rain, *Water pollution sources, *Chemical analysis, *California, *Lakes, Streams, *Water quality, Hydrogen ion concentration, Conductivity, Temperature, Calcium, Magnesium, Sodium, Potassium, Nitrates, Sulfates, Chloride, Phosphates, Aluminum, Iron, Man-

ganese, Molybdenum, Copper, Selenium, Zinc, Fish.

During 1985, the water quality of 50 California lakes and streams was examined on two occasions, once during the period of spring runoff and again during the fall dry period. Parameters measured included pH, alkalinity, hardness, conductivity, temperature, major cations (calcium, magnesium, sodium, and potassium), major anions (nitrate, sulfate, chloride, and phosphate), as well as total and dissolved concentrations of the trace elements aluminum, iron, manganese, molybdenum, and total concentrations of copper, selenium, and zinc. These water quality parameters were seasonally variable. Surface waters in northeast and northwest California and the Sierra Nevada typically demonstrated low alkalinity (< 200 microeq/L), low ionic strength (Ca(2+) < 100 microeq/L; Mg(2+) < 80 microeq/L), and low conductivity (<22 microsiemens/cm). These characteristics identify the sampled waters as sensitive to the effects of acid deposition and susceptible to acidification. Five lakes (10%) of those sampled demonstrated some characteristics of waters that are intermediate between those that are bicarbonate buffered and those that are acidified. The cause of this apparent acidification is presently unknown but either acid deposition or the presence of organic acids are considered possible. Regardless of the source of acidification, it is unlikely that healthy fish populations survive in some of the lakes examined. (Author's abstract)
W89-04833

PARTICULATE MONITORING FOR ACID DEPOSITION RESEARCH AT SEQUOIA NATIONAL PARK, CALIFORNIA,
California Univ., Davis. Crocker Nuclear Lab.
T. A. Cahill, H. J. Annegarn, D. Ewell, and P. J. Feeney.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-121629. Price codes: A06 in paper copy, A01 in microfiche. Final Report, May 1986. 118p, 32 fig, 7 tab, 6 ref, 5 append. California Air Resources Board Contract A4-124-32.

Descriptors: *Water pollution sources, *Acid rain, *Monitoring, *California, *Sequoia National Forest, Lead, Hydrogen, Meteorology, Path of pollutants, Rainfall.

In support of the acid deposition effects programs at Sequoia National Park, extensive measurements of particulate matter were made during the summer of 1985. The objectives of the project were: (1) to characterize the particulate composition of fine particles by determining the concentration of all elements from hydrogen through lead; (2) to determine what material is available for wet and dry deposition by measuring particulate concentrations by element with detailed size and time resolution; (3) to determine how particulate concentrations vary with time as the meteorology changes; (4) to determine the extent of transport of particulate pollutants from the San Joaquin Valley by comparing elemental concentrations measured at three elevations with sufficient time resolution to look at transport; and (5) to provide convenient time plots and other visual representations of particulate concentrations to concurrent projects on the effects of wet and dry deposition and to studies dealing with meteorology and gasses. Samples were taken continuously at three elevations (2000 ft, 6400 ft, 10000 ft) in up to nine size ranges. Almost 4000 analyses were done for mass, carbon soot, hydrogen, and elemental species up through lead. The data were correlated with local and synoptic meteorology, known elemental source signatures, and wet deposition measurements made in the four major rain events during the summer of 1985. The results show that particulate matter at Sequoia NP is similar to that measured at other, non-urban sites in the Sierra Nevada range and California desert. Particles were carried into the study sites by both local, terrain effect winds coming from the central San Joaquin Valley, and by upper level synoptic flows south and east of Sequoia NP. Rainfall associated with the latter flows contributed most of the wet deposition acidic flux (H, SO4(2-), NO(3-)) in the study period. (Author's abstract)
W89-04834

FACTORS AFFECTING THE MOBILIZATION, TRANSPORT, AND BIOAVAILABILITY OF MERCURY IN RESERVOIRS OF THE UPPER MISSOURI RIVER BASIN,
Montana Cooperative Fishery Research Unit, Bozeman.
G. R. Phillips, P. A. Medvick, D. R. Skaar, and D. E. Knight.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-122585. Price codes: A04 in paper copy, A01 in microfiche. Fish and Wildlife Technical Report 10, 1987. 64p, 36 fig, 26 tab, 173 ref.

Descriptors: *Mercury, *Missouri River, *Path of pollutants, Bioaccumulation, Fish, Tongue River Reservoir, Limnology, Cookson Reservoir, Nelson River, Hydrogen ion concentration, Conductivity, Flooding, Erosion, Temperature effects, Sediments, Sediment-water interface.

Factors controlling the mobilization, transport, and bioavailability of mercury in relation to coal mining and other mercury sources were studied in reservoirs of the Upper Missouri River Basin. Mercury and selenium contamination of fishes and sediments in 10 reservoirs were assessed, mercury fluxes in Tongue River Reservoir were estimated, dietary accumulation of methylmercury by fish was determined, and limnological conditions in three reservoirs that affect rates of mercury accumulation by fish were investigated. Detailed limnological studies were conducted in Nelson, Cookson, and Tongue River reservoirs. Mercury concentrations were higher in walleyes from headwater reservoirs with unregulated inflows than in fish of the same size from downstream reservoirs. Erosion and leaching during flooding apparently facilitated mercury accumulation by fish in reservoirs. Of the three reservoirs studied, the rate of mercury uptake by fish was highest in Cookson Reservoir, followed by Nelson and Tongue River reservoirs. Characteristics of Cookson that facilitated mercury uptake included the relatively young age of the reservoir, high bacterial counts at the inflow, high water temperatures at the sediment-water interface, a low percentage of clay in the sediments, and the relatively high pH and conductivity of the water. Alternatively, factors contributing to the lower rate of mercury uptake by fish in Tongue River Reservoir included incomplete thermal mixing that resulted in cooler bottom waters, more reducing conditions near the bottom, more clay-like sediments, and higher concentrations of sulfide and oxides of iron and manganese in the sediments. Physicochemical conditions in some reservoirs seemingly enhance the bioavailability of mercury to fish, even in the absence of high mercury concentrations in sediments and water. Spillway design, basin shape, reservoir flow characteristics, watershed geochemistry, and other upstream conditions affect the vulnerability of a new reservoir to mercury problems. (Lantz-PTT)
W89-04838

EPA ACTIVITIES RELATED TO SOURCES OF GROUND-WATER CONTAMINATION.
Environmental Protection Agency, Washington, DC. Office of Ground-Water Protection.
For primary bibliographic entry see Field 2F.
W89-04851

SYNTHESIS OF THE RESULTS OF THE FIELD VERIFICATION PROGRAM UPLAND DISPOSAL ALTERNATIVE,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Effects Lab.
B. L. Folsom, J. G. Skogerboe, M. R. Palermo, J. W. Simmers, and S. A. Pranger.
Available from the National Technical Information Service, Springfield, VA 22161. Technical Report D-88-7, October 1988. Final Report. 85p, 24 fig, 16 tab, 49 ref.

Descriptors: *Dredge spoil disposal, *Waste disposal, *Path of pollutants, *Land disposal, *Spoil banks, *Sediments, Surface water, Groundwater quality, Bioaccumulation, Path of pollutants, Earthworms, Heavy metals, Zinc, Cadmium, Manganese, Nickel, Polychlorinated biphenyls, Spartina, Bioassays.

Contaminated dredged material from the Black Rock Harbor (BRH) maintenance dredging project in the U.S. Army Corps of Engineers New England Division was used to field verify: (a) procedures for predicting the quality of effluent discharged from the upland site during filling operations; (b) procedures for predicting the quality of upland surface runoff resulting from rainfall following disposal; (c) possible changes in groundwater quality following disposal; (d) procedures for predicting potential contaminant mobility into plants; and (e) procedures for predicting potential contaminant mobility into animals. The surface runoff water quality test procedure was conducted on the upland site. Results verified the laboratory predictions; zinc, cadmium, copper, manganese, and nickel were in the dissolved fraction of runoff water in concentrations that exceeded the USEPA Water Quality Criteria. Results of the groundwater monitoring at the upland site indicated that an initial plume of PCBs may have migrated into the groundwater after placement of the BRH sediment into the site. However, after 14 months, PCB levels had decreased to below detectable limits, which indicated that any migration from the site had ceased. The estuarine plant bioassay procedure was used in the laboratory to evaluate heavy metal uptake by plants from composited BRH sediment. Death of Spartina alterniflora in the site was so clearly predicted by the laboratory tests and an in situ field plant bioassay that S. alterniflora was not tested further in the field. However, Sporobolus virginicus survived in limed dredged material, as predicted. Lead contents were predicted to be low in greenhouse-grown plants. Initial earthworm bioassays indicated that the sediment was quite toxic. However, subsequent tests indicated that the toxicity was apparently due to extreme sediment salinity. (Lantz-PTT)
W89-04853

ACID DEPOSITION IN MARYLAND: THE STATUS OF KNOWLEDGE IN 1987.
For primary bibliographic entry see Field 5C.
W89-04861

NATIONAL ACID PRECIPITATION ASSESSMENT PROGRAM,
For primary bibliographic entry see Field 5A.
W89-04862

ATMOSPHERIC TRANSPORT, TRANSFORMATION, AND DEPOSITION,
C. Maxwell, and S. Kumar.
IN: Acid Deposition in Maryland: The Status of Knowledge in 1987. Maryland Power Plant Research Program Report No. AD-88-1, January 1988. p 51-80, 1 fig, 12 tab, 43 ref.

Descriptors: *Acid rain, *Water pollution sources, *Path of pollutants, *Air pollution, *Maryland, Sulfates, Nitrates, Monitoring, Sulfur dioxide, Nitrogen oxides, Model studies, Fate of pollutants.

Present emissions of sulfur and nitrogen oxides in Maryland are 310,910 tons and 231,587 tons, respectively. Approximately 70% of SO2 emissions generated within Maryland are due to power plants while the remainder comes from other industrial sources. In contrast, about 50% of NOx emissions are from mobile sources, 29% from power plants, and the remainder from industrial sources. The deposition of acid materials is a complex process that occurs not only with precipitation, fog, and dew, but also during dry periods through the settling of acidic particles, such as sulfates and nitrates. Monitoring programs to measure wet deposition have been established at the federal and state level for rural areas and have been active for several years. The results given in last year's report indicate that across Maryland, the annual average pH of precipitation ranges from 4.0 to 4.2. These values will change slightly from year to year but were relatively constant from the mid-1970s through the mid-1980s. To date, no signifi-

cant trends have been identified in precipitation acidity in the eastern U.S. Dry deposition monitoring programs are just beginning. Extensive research has been completed to determine the chemical reactions that transform sulfur dioxide (SO2) and nitrogen oxides (NOx) emissions to the acidic sulfates (SO4) and nitrates (NO3) found in precipitation. The conversion of nitrogen oxides to nitrate is principally due to gas phase reactions, while sulfur dioxide is transformed most efficiently to sulfate in liquid phase reactions. The chemical reactions depend on many meteorological and atmospheric variables, such as solar radiation intensity, the number and type of clouds, relative humidity, and the presence of other pollutants (e.g. volatile organic carbons) or oxidants (e.g. ozone and hydrogen peroxide) in the air. Several modeling studies and trajectory analyses have focused on the sources of acid rain precursors for the northeastern United States. These studies have found that the primary source region for acid rain precursors that affect the northeast are from the west and southwest of the region. The primary sulfur dioxide source region appears to be more distant than the primary nitrogen oxides source region. (See also W89-04861) (Lantz-PTT)
W89-04863

WATERSHEDS,
G. DeMuro, R. Keating, and A. Janicki.
IN: Acid Deposition in Maryland: The Status of Knowledge in 1987. Maryland Power Plant Research Program Report No. AD-88-1, January 1988. p 81-105, 7 fig, 1 tab, 30 ref.

Descriptors: *Acid rain, *Path of pollutants, Watersheds, *Groundwater, *Maryland, *Soil chemistry, Neutralization, Acidification, Hydrogen ion concentration.

The interaction of acid precipitation with watershed components of soil, geologic units, and groundwater was thoroughly evaluated. Often the components of the watershed can provide neutralization of anthropogenic acidic inputs and thus minimize the adverse effects of acid precipitation on watersheds. In general the following conclusions can be drawn about the ability of Maryland geologic units and soils to buffer acidity: Bedrock systems in the Piedmont and Appalachian physiographic provinces and unconsolidated sediments of the Coastal Plain Province have a medium-to-low ability to neutralize acidity; and, Maryland soils do not possess sufficient capacity to neutralize natural acidification processes, which may be more severe than that caused by acidic deposition. Land management practices, however, can affect the ability of a soil to neutralize acidic inputs. Soil amendments such as limestone and activities reducing the contact time of rainwater with soils in the watershed can influence the response of surface water to acid deposition. Based on limited data, no overall effect of acid deposition on groundwater quality has been observed. A study of the Columbia aquifer on Maryland's Eastern Shore indicated that groundwater used as drinking water was not affected by acid deposition. Shallow groundwater, however, appeared to have elevated aluminum concentrations and depressed pH. (See also W89-04861) (Lantz-PTT)
W89-04864

ACID DEPOSITION PRECURSOR CONTROL TECHNOLOGIES,
C. McManus.
IN: Acid Deposition in Maryland: The Status of Knowledge in 1987. Maryland Power Plant Research Program Report No. AD-88-1, January 1988. p 145-163, 1 fig, 9 tab, 17 ref.

Descriptors: *Waste disposal, *Maryland, *Water pollution sources, *Water pollution prevention, *Water quality control, *Acid rain, Air pollution, Nitrates, Nitrites, Sulfates, Combustion, Groundwater protection, Environmental protection.

Pre-combustion control technologies encompass physical, chemical, and biological sulfur removal processes. Of the three, physical coal cleaning is by far the most widely used process. Combustion control technologies include burner modifications, fluidized bed combustion technology, and sorbent injection into burners. NOx emissions are limited by reducing the flame temperature while limestone is used to control SO2 emissions. Post-combustion control technologies include wet and dry flue gas scrubbing processes for SO2 removal and ammonia-based processes for NOx control. Gasification combined cycle (GCC) combines production of fuel gas from controlled coal combustion with a combustion turbine and a steam turbine to generate electricity. In 1987, Potomac Electric Power Company (PEPCO) announced plans for phase licensing and construction of two 375 MW Gasification-Combined Cycle (GCC) units, each composed of two 125 MW combustion turbines, a 125 MW combined cycle unit, and a coal gasifier. Public hearings began in September 1987. Siting studies, concept design work, and baseline environmental monitoring also began in 1987. To date, no utility wastes (e.g., fly ash, scrubber sludge) have been classified as hazardous. Current disposal practices in Maryland are guided by 'best engineering practice' and the goal of no impact to groundwater. The degree of control and type of equipment required will be dictated by maryland's sharer of any federally-mandated SO2 or NOx emissions reductions and the nature of the control bill enacted. Studies of two emissions reduction scenarios led to control strategies using a mix of combustion of lower sulfur fuel, low-NOx burners, and conventional wet lime or limestone scrubbers. At present the conversion of coal-fired utilities to low sulfur coal will likely provide the most significant reduction in SO2 emissions. (See also W89-04861) (Lantz-PTT)
W89-04868

FEDERAL AND STATE INITIATIVES,
For primary bibliographic entry see Field 5G.
W89-04871

INTENSIVE SURVEY OF THE ILLINOIS RIVER (ARKANSAS AND OKLAHOMA) IN AUGUST 1985,
Environmental Research Lab.-Duluth, MN.
For primary bibliographic entry see Field 2E.
W89-04872

PESTICIDE ASSESSMENT GUIDELINES SUBDIVISION N, CHEMISTRY: ENVIRONMENTAL FATE. SERIES 161-2 AND 161-3, PHOTOLYSIS STUDIES. ADDENDUM 4 ON DATA REPORTING,
Environmental Protection Agency, Washington, DC. Office of Pesticide Programs.
S. M. Creeger, and E. B. Conerly.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-159900. Price codes: A03 in paper copy, A01 in microfiche. January 1988. 8p.

Descriptors: *Pesticides, *Fate of pollutants, *Standards, *Photolysis, Water quality control, Light intensity, Chemical analysis, Monitoring.

The Data Reporting Guideline (DRG) for Photolysis Studies in Water and on Soil, Series 161-2 and 161-3, gives guidance to pesticide registrants on the format for their study report so that the Agency can review it efficiently. This guidance clarifies sections in the existing Pesticides Assessment Guidelines, Subdivision N, on data reporting. It provides an outline for the study report and describes the topics which should be addressed such as the light source and relationship to natural sunlight, characteristics of the soil or water used, the equipment, experimental design, analytical method, description of the handling and analysis of samples and provides guidance on the presentation of the results of the study. Data submitters can use the DRG in preparing their reports for submission to EPA to meet 40 CFT 158 requirements for the registration of pesticides. (Author's abstract)
W89-04874

PESTICIDE ASSESSMENT GUIDELINES SUBDIVISION N, CHEMISTRY: ENVIRONMENTAL FATE. SERIES 161-1, HYDROLYSIS STUDIES ADDENDUM 3 ON DATA REPORTING,
Environmental Protection Agency, Washington, DC. Office of Pesticide Programs.
S. M. Creeger, and F. B. Conerly.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-159892. Price codes: A03 in paper copy, A01 in microfiche. January 1988. 8p.

Descriptors: *Pesticides, *Fate of pollutants, *Standards, *Hydrolysis, Water quality control, Chemical analysis, Monitoring, Sample preparation.

The Data Reporting Guideline (DRG) for Hydrolysis Studies, Series 161-1, gives guidance to pesticide registrants on the format for their study report so that the agency can review it efficiently. This guidance clarifies sections in the existing Pesticides Assessment Guidelines, Subdivision N, on data reporting. It provides an outline for the study report and describes the topics which should be addressed such as sampling intervals, source or preparation of buffers, the equipment used, method of sterilization, pH monitoring, description of the handling and analysis of samples, etc. and provides guidance on the presentation of the results of the study. Data submitters can use the DRG in preparing their reports for submission to EPA to meet 40 CFR 158 requirements for the registration of pesticides. (Author's abstract)
W89-04875

INTEGRATED APPROACH TO A STUDY OF CONTAMINANTS AND TOXICITY IN MONROE HARBOR (RIVER RAISIN), MICHIGAN, A GREAT LAKES AREA OF CONCERN: SUMMARY REPORT.
Environmental Research Lab.-Duluth, Grosse Ile, MI. Large Lakes Research Station.
For primary bibliographic entry see Field 5A.
W89-04877

SPATIAL AND TEMPORAL DISTRIBUTION OF PRECIPITATION CHEMISTRY ACROSS MARYLAND IN 1984. VOLUME 1,
Versar, Inc., Columbia, MD.
C. Maxwell, and S. Mahn.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-148929. Price codes: A06 in paper copy, A01 in microfiche. Maryland Power Plant Research Program Report AD-87-10, September 1987. 102p, 29 fig, 6 tab, 21 ref, 3 append. Contract PR86-040-01.

Descriptors: *Acid rain, *Water pollution sources, *Maryland, *Air pollution, *Data collections, *Sulfates, *Nitrates, Ammonium, Sodium, Chlorides, Potassium, Magnesium, Hydrogen ion concentration, Statistical studies, Spatial distribution, Temporal distribution.

A database containing precipitation chemistry data collected by multiple monitoring programs in and around Maryland for 1984 was compiled. The data were checked for quality and consistency. Isopleth maps were constructed showing the spatial variation in the precipitation concentrations and depositions of hydrogen ion, sulfate, nitrate, ammonium, calcium, sodium, chloride, potassium, and magnesium. In addition, isopleths of observed precipitation amount and pH were prepared. Temporal and regression analyses were also completed. For each parameter, the concentration pattern was very similar to its deposition pattern. This was expected since large gradients in precipitation amount generally were observed only in the mountainous regions; otherwise, precipitation amount varied smoothly. The sulfate concentration and deposition patterns were very similar to the nitrate patterns, but the sulfate patterns exhibited greater temporal variability and nitrate patterns exhibited greater spatial variability. Hydrogen ion concentration and deposition patterns were similar, but not identical to sulfate concentration and deposition patterns. The patterns suggest the occurrence of a ridge of high sulfate and hydrogen ion concentrations and depositions extending from south-central Pennsylvania, south into Maryland along the western shore of the Chesapeake Bay. (See also W89-04890) (Author's abstract)

W89-04889

SPATIAL AND TEMPORAL DISTRIBUTION OF PRECIPITATION CHEMISTRY ACROSS MARYLAND IN 1984. VOLUME 2,
Versar, Inc., Columbia, MD.
C. Maxwell, and S. Mahn.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-148937. Price codes: A18 in paper copy, A01 in microfiche. Maryland Power Plant Research Program Report No. AD-87-10, September 1987. 361p. Contract PR86-040-01.

Descriptors: *Acid rain, *Water pollution sources, *Air pollution, *Data collections, *Maryland, *Spatial distribution, *Sulfates, *Nitrates, Ammonium, Sodium, Chlorides, Potassium, Magnesium, Hydrogen ion concentration, Statistical studies, Temporal distribution.

A database containing precipitation chemistry data collected by multiple monitoring programs in and around Maryland for 1984 was compiled. The data were checked for quality and consistency. Isopleth maps were constructed showing the spatial variation in the precipitation concentrations and depositions of hydrogen ion, sulfate, nitrate, ammonium, calcium, sodium, chloride, potassium, and magnesium. In addition, isopleths of observed precipitation amount and pH were prepared. Temporal and regression analyses were also completed. For each parameter, the concentration pattern was very similar to its deposition pattern. This was expected since large gradients in precipitation amount generally were observed only in the mountainous regions; otherwise, precipitation amount varied smoothly. Summary statistics and seasonal values for total precipitation, average concentrations, pH, and total depositions are provided in the appendices in this volume. (See also W89-04889) (Lantz-PTT)
W89-04890

UPPER GREAT LAKES CONNECTING CHANNELS STUDY; DETROIT RIVER SYSTEM MASS BALANCE (UGLCCS ACTIVITIES C.1 AND F.4).
Environmental Research Lab.-Duluth, Grosse Ile, MI. Large Lakes Research Station.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-1158514. Price codes: A10 in paper copy, A01 in microfiche. Report No. EPA/600/3-88/003, January 1988. 182p, 42 fig, 67 tab, 24 ref, 5 append.

Descriptors: *Great Lakes, *Detroit River, *Monitoring, *Path of pollutants, *Fate of pollutants, Suspended solids, Organic carbon, Water quality, Chlorides, Silicate, Nickel, Mercury, Hexachlorobenzene, Cadmium, Iron, Lead, Zinc, Heavy metals, Regulations, Chemical analysis.

A study of water quality budgets in the Lake St. Clair - Detroit River system, was designated Activities C.1 and F.4 of the U.S.-Canadian Upper Great Lakes Connecting Channels Study. During April 21-29, and July 25-August 5, 1986, profiles of contaminants and other chemical factors were measured every 12 hours across transects of the upper and lower Detroit River. Average concentrations of the same parameters were also determined for stations near the mouths of four main tributaries during this period. Parameters included suspended solids, chloride, silicate, phosphorus, hardness, organic carbon, iron, lead, cadmium, zinc, copper, nickel, mercury, hexachlorobenzene (HCB), octachlorostyrene (OCS) and PCB congeners. Concentrations of all parameters were multiplied by river and tributary flows to compute chemical mass loadings into and out of the Detroit River system. Mass imbalances, calculated as the difference between river head and mouth loadings, indicated significant gains for nearly all parameters within a given water mass during its 18 hour passage through the system. Tributary loadings appeared to account for only a minor part of the observed gains in Detroit River loadings. Other point and nonpoint sources are being evaluated by the UGLCCS committees as potential sources of the unexplained loading. Findings will be used to set priorities for regulatory actions for reducing contaminant loads. The study design, involving spatial and temporal composite sampling to minimize cost, appeared to provide adequate characterization of water chemistry and loadings. It also provided sufficient information to discern mass loading differences. The strategy developed here provides a framework for long term study of water quality dynamics in the Detroit River, and may serve as a model for similar studies of other connecting channels. (Author's abstract)
W89-04893

MEASUREMENT OF VERTICAL TURBULENT DISPERSION AND DIFFUSION OF OIL DROPLETS AND OILED PARTICLES.
Engineering Hydraulics, Inc., Redmond, WA.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-159009. Price codes: A18 in paper copy, A01 in microfiche. Report No. OCS Study MMS 87-111, December 1987. 501 p, 235 fig, 16 tab, 43 ref, 2 append. Department of the Interior, Minerals Management Service Contract 14-12 0001-30268. Project 438-005.

Descriptors: *Path of pollutants, *Oil spills, *Mathematical studies, Suspended solids, Oil slicks, Oil-water interfaces, Mathematical equations, Seawater, Waves.

This study is part of a research program to develop mathematical models for the transport of spilt oil and the interaction of oil with suspended particulate matter (SPM) in the sea. Laboratory experiments were conducted to provide the mathematical models with empirical data on oil dispersion and oil-SPM interaction. Empirical relations and data were obtained for the following processes: (a) break-up of surface oil films into droplets, and intrusion of droplets in the water column, due to breaking wave effects; (b) break-up of submerged oil parcels (submerged leak) into droplets due to turbulence in the seawater; and (c) interaction between oil droplets and SPM. The experiments were performed in three different laboratory facilities: (1) a grid column for experiments on submerged oil and oil-SPM interaction; (2) a small-scale wave flume for extensive series of experiments on dispersion of surface oil; and (3) a large-scale wave flume to relate the small-scale results to field conditions. The oil-SPM experiments led mainly to qualitative results on the influence of various parameters on the interaction process. The experiments on the break-up of surface oil films due to breaking waves led to the following quantitative relations: (a) an empirical relation for the entrainment Q, as a function of the breaking wave energy, film thickness, oil type and temperature; (b) a droplet size distribution as a function of these parameters; and (c) intrusion depth related to wave height and bore height. The experiments on submerged oil in a turbulent ambience resulted in relations for the droplet size distribution in dependence of various parameters. The empirical relations can be used in mathematical models with given hydrodynamic conditions and breaking wave statistics. (Author's abstract)
W89-04895

LABORATORY PROTOCOL FOR DETERMINING FATE OF WASTE DISPOSED IN DEEP WELLS,
National Inst. for Petroleum and Energy Research, Bartlesville, OK.
A. G. Collins, and M. E. Crocker.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-166061. Price codes: A04 in paper copy, A01 in microfiche. Report No. EPA/600/8-88/008, February 1988. 63p, 9 fig, 9 tab, 22 ref, 5 append. EPA Contract DW89931947.

Descriptors: *Underground waste disposal, *Hazardous wastes, *Injection wells, *Fate of pollutants, *Waste disposal, *Deep wells, Adsorption, Degradation, Organic compounds, Injection wells, Hazardous wastes.

The objective of this research investigation was to develop a laboratory protocol for use in determining degradation, interaction, and fate of organic wastes disposed in deep subsurface reservoirs via disposal wells. Knowledge of the ultimate fate of deep-well disposed wastes is important because provisions of the Resource Conservation and Recovery Act (RCRA) require that by August 1988, the EPA must show that the disposal of specified wastes by deep-well injection is safe to human health and the environment, or the practice must be stopped. The National Institute for Petroleum and Energy Research (NIPER) developed this protocol primarily by transferring some of its expertise and knowledge of laboratory protocol relevant to improved recovery of petroleum. This study was designed to investigate the adsorption properties of a specific reservoir rock which is representative of porous sedimentary geologic formations used as repositories for hazardous organic wastes. Phenol is the principal hazardous waste product that has been injected into the Frio formation; therefore, a decision was made to use phenol and sedimentary rock from the Frio formation for a series of laboratory experiments to demonstrate the protocol. The protocol can be used to evaluate mobility, adsorption, and degradation of an organic hazardous waste under simulated subsurface reservoir conditions. (Lantz-PTT)
W89-04897

RECONNAISSANCE INVESTIGATION OF WATER QUALITY, BOTTOM SEDIMENT, AND BIOTA ASSOCIATED WITH IRRIGATION DRAINAGE IN THE KENDRICK RECLAMATION PROJECT AREA, WYOMING, 1986-87,
Geological Survey, Cheyenne, WY. Water Resources Div.
For primary bibliographic entry see Field 5C.
W89-04899

SEDIMENTATION AND WATER QUALITY IN THE WEST BRANCH SHADE RIVER BASIN, OHIO, 1983-85,
Geological Survey, Columbus, OH. Water Resources Div.
C. J. Oblinger Childress, and R. L. Jones.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 87-4262, 1988. 56p, 8 fig, 7 tab, 21 ref.

Descriptors: *Coal mine effects, *Water pollution sources, *Sedimentation, *Water quality, *Ohio, Coal mining, Acid mine drainage, Land reclamation, Suspended sediments, Sediment load, Sediment concentration, Runoff, Streamflow, Water sampling, Hydrologic data collections, River basins.

Loss of channel conveyance from deposition of sediment from abandoned surface mines in the West Branch Shade River basin has resulted in frequent flooding. In addition, water quality in the West Branch Shade River and some of its tributaries is typical of streams affected by acid mine drainage. About 938 acres were surface mined and abandoned in West Branch Shade River basin. By the end of the 1984, about 450 acres were reclaimed. The purpose of this study was to measure the effects of abandoned surface mines and their reclamation on suspended-sediment load, channel cross-section profile, and water quality of West Branch Shade River. Daily suspended-sediment samples were collected and continuous streamflow data were recorded at two locations in West Branch Shade River basin and one location in the unmined, East Branch Shade River basin. Streamchannel cross sections were surveyed at least twice per year at 10 locations. Annual suspended-sediment concentration, in tons per acre foot, in West Branch Shade River near Harrisonville, which was 100 percent reclaimed by the end of 1984, decreased from 8.6 in 1984 water year to 0.15 in 1985 water year. Channel profiles, surveyed at each of the 10 cross sections, indicated scouring at two locations and filling at one location. West Branch Shade River near Harrisonville was scouring, whereas West Branch Shade River near Burlingham was filling. The quality of West Branch Shade River was characteristic of streams draining

abandoned at improperly reclaimed surface mines in southeastern Ohio. Median alkalinity was less than 25 mg/L (milligrams per liter) as CaCO3 at the three mined sites. Median sulfate concentration was 44 mg/L at the unmined sites compared to 128 mg/L at the mined sites. Both sulfate and manganese are indicators of the presence of acid mine drainage. The greatest change in water quality during the study period was observed in West Branch Shade River near Harrisonville, above which all abandoned mine lands were reclaimed. The pH at that site increased to neutral by the end of the study. In addition, alkalinity concentration increased, and acidity concentration decreased. (Author's abstract)
W89-04901

QUALITY-ASSURANCE RESULTS FOR FIELD PH AND SPECIFIC-CONDUCTANCE MEASUREMENTS, AND FOR LABORATORY ANALYSIS, NATIONAL ATMOSPHERIC DEPOSITION PROGRAM AND NATIONAL TRENDS NETWORK--JANUARY 1980-SEPTEMBER 1984,
Geological Survey, Denver, CO. Water Resources Div.
For primary bibliographic entry see Field 5A.
W89-04920

PROGRAMMERS MANUAL FOR A ONE-DIMENSIONAL LAGRANGIAN TRANSPORT MODEL,
Geological Survey, NSTL Station, MS. Water Resources Div.
For primary bibliographic entry see Field 7C.
W89-04923

USERS MANUAL FOR A ONE-DIMENSIONAL LAGRANGIAN TRANSPORT MODEL,
Geological Survey, NSTL Station, MS. Water Resources Div.
For primary bibliographic entry see Field 7C.
W89-04924

WATER QUALITY IN THE LOWER PUYALLUP RIVER VALLEY AND ADJACENT UPLANDS, PIERCE COUNTY, WASHINGTON,
Geological Survey, Tacoma, WA. Water Resources Div.
J. C. Ebbert, G. C. Bortleson, L. A. Fuste, and E. A. Prych.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, Co 80225. USGS Water Resources Investigations Report 86-4154. 1987. 199p, 31 fig, 24 tab, 34 ref, 1 plate in pocket.

Descriptors: *Water resources data, *Groundwater resources, *Surface water, *Water pollution sources, *Data collections, *Wastewater pollution, *Puyallup River, Groundwater pollution, Iron, Manganese, Alluvial aquifers, Organic compounds, Sediments, Fluvial sediments, Trace elements, Arsenic, Lead, Zinc, Urban runoff, Suspended sediments, Dissolved oxygen.

The quality of most ground and surface water within and adjacent to the lower Puyallup River valley is suitable for most typical uses; however, some degradation of shallow groundwater quality has occurred. High concentrations of iron and manganese were found in groundwater, sampled at depths of < 40 ft, from wells tapping alluvial aquifers and in a few wells tapping deeper aquifers. Volatile and acid- and base/neutral-extractable organic compounds were not detected in either shallow or deep groundwater samples. The quality of shallow groundwater was generally poorer than that of deep water. Deep ground water (wells set below 100 ft) appears suitable as a supplementary water supply for fish-hatchery needs. Some degradation of water quality, was observed downstream from river mile 1.7 where a municipal wastewater-treatment plant discharges into the river. In the Puyallup River, the highest concentrations of most trace elements were found in bed sediments collected downstream from river mile 1.7. Median concentrations of arsenic, lead, and zinc were higher in bed sediments from small streams compared with those from the Puyallup River, possibly because the small stream drainages, which are almost entirely within developed areas, receive more urban runoff as a percentage of total flow. Total-recoverable trace-element concentrations exceeded water-quality criteria for acute toxicity in the Puyallup River and in some of the small streams. In most cases, high concentrations of total-recoverable trace elements occurred when suspended-sediment concentrations were high. Temperatures in all streams except Wapato Creek and Fife Dutch were within limits (18 C) for Washington State class A water. Minimum dissolved oxygen concentrations were relatively low at 5.6 and 2.0 mg/L, respectively, for Wapato Creek and Fife Dutch. The poorest surface-water quality, which can be characterized as generally unsuitable for fish, was in Fife Dutch, a manmade channel and therefore uncharacteristic of other small streams. (Author's abstract)
W89-04930

DESCRIPTION OF THE HYDROLOGIC SYSTEM AND THE EFFECTS OF COAL MINING ON WATER QUALITY IN THE EAST FORK LITTLE CHARITON RIVER AND THE ALLUVIAL AQUIFER BETWEEN MACON AND HUNSTVILLE, NORTH-CENTRAL MISSOURI,
Geological Survey, Rolla, MO. Water Resources Div.
D. C. Hall.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4160. 1986. 66p, 4 tab, 14 ref.

Descriptors: *Coal mine effects, *Acid mine drainage, *Coal mining, *Strip mines, *Water pollution sources, *Groundwater pollution, Alluvial aquifers, Sulfates, Dissolved solids, Mine wastes.

The quality of surface and groundwater has been affected by abandoned strip mines and by abandoned underground mines in a 110-sq mi subbasin of the East Fork Little Chariton River. More than 14% of the area was strip mined for coal before 1979. The hydrologic system in the area was investigated and the effects of coal mining on quality of water in the river and alluvial aquifer were analyzed, with major emphasis on defining strip-mining effects. The groundwater gradient was from glacial drift or coal spring to alluvium to the East Fork Little Chariton River, and was greatest in spring and least in fall. Seepage from alluvium to the East Fork Little Chariton River occurs throughout the year, except during drought conditions when the only river flow is water released from Long Branch Lake. In the East Fork Little Chariton River median dissolved-solids concentrations increased from 153 mg/L near Macon to 630 mg/L near Huntsville and median sulfate concentrations increased from 36 mg/L near Macon to 360 mg/L near Huntsville. The median dissolved-solids concentration in water from the alluvium increased from 408 mg/L upstream from the strip mines to 641 mg/L near the mines and median dissolved-sulfate concentration increased from 140 to 350 mg/L. The sulfate-to-chloride ratio, used as the most sensitive indicator of strip-mining effects, increased markedly downstream in the East Fork Little Chariton River and nearby Middle Fork Little Chariton River, which also is affected by strip mining. There were no significant increases in sulfate-to-chloride ratio and dissolved-solids concentrations in comparable nearby subbasins of the Grand, Thompson, and Chariton Rivers where there was no mining. (Author's abstract)
W89-04934

EFFECTS OF LAND USE ON GROUNDWATER QUALITY IN CENTRAL FLORIDA--PRELIMINARY RESULTS: U.S. GEOLOGICAL SURVEY TOXIC WASTE--GROUNDWATER CONTAMINATION PROGRAM,
Geological Survey, Tallahassee, FL. Water Resources Div.
A. T. Rutledge.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4163. 1987. 49p, 13 fig, 16 tab, 29 ref.

Descriptors: *Water pollution sources, *Groundwater pollution, *Storm runoff, *Pesticides, *Phosphate mining, *Florida, Aquifers, Storm water, Agricultural chemicals, Citrus fruits, Urban areas, Drainage wells, Organic compounds, Arsenic, Selenium, Mercury, Lead, Chromium, Cadmium.

Groundwater is the principal source of drinking water in central Florida. The most important hydrogeologic unit is the Floridan aquifer system, consisting of fractured limestone and dolomite limestone. Activities of man in areas of recharge to the Floridian aquifer system that may be affecting groundwater quality include: (1) the use of drainage wells for stormwater disposal in urban areas, (2) the use of pesticides and fertilizers in citrus groves, and (3) the mining and processing of phosphate ore in mining areas. Preliminary findings about the impacts of these land uses on groundwater quality by comparison with a fourth land use representing the absence of human activity in another area of recharge are presented. Drainage wells convey excess urban stormwater directly to the Upper Floridian aquifer. The volatile organic compounds are the most common contaminants in ground water. Trace elements such as chromium and lead are entering the aquifer but their movement is apparently attenuated by precipitation reactions associated with high pH or by cation-exchange reactions. Among the trace elements and organic chemicals, most ground-water contamination in citrus production areas is caused by pesticides, which include the organic compounds simazine, ametryne, chlordane, DDE, bromacil, aldicarb, EDB, trifluralin, and diazinon, and the trace elements zinc and copper; other contaminants include benzene, toluene, napthalene, and indene compounds. In the phosphate mining area, constituents of concern are arsenic, selenium, and mercury, and secondarily lead, chromium, cadmium, and others. Organic compounds such as fluorene, naphthalene, di-n-butyl phthalate, alkylated benzenes and naphthalenes, and indene compounds also are entering groundwater. (Author's abstract)
W89-04936

GEOHYDROLOGIC RECONNAISSANCE OF A GROUND-WATER CONTAMINATION PROBLEM IN THE ARGONNE ROAD AREA NEAR SPOKANE, WASHINGTON,
Geological Survey, Tacoma, WA. Water Resources Div.
N. P. Dion.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4173. 1987. 37p, 9 fig, 5 tab, 24 ref, append.

Descriptors: *Water pollution sources, *Chlorinated hydrocarbons, *Path of pollutants, *Groundwater pollution, Groundwater movement, *Spokane Aquifer, Sludge disposal, Septic systems, Plumes, Domestic water, Wells, Aquifers, Organic solvents.

Three domestic wells that withdraw groundwater from an alluvium-filled trough cut into granite were found to be contaminated with the organic solvents tetrachloroethene, trichloroethene, 1,1,1-trichloroethane, and 1,2-trans-dichloroethene. The suspected source of contamination is a nearby septic-tank sludge disposal area. There is concern that the affected aquifer is tributary to the Spokane aquifer, which has been accorded 'sole source' status by the U.S. Environmental Protection Agency. Preliminary estimates suggest that groundwater in the area is moving toward the Spokane aquifer and that the transit time may range from 2.5 to 25 years. Because of longitudinal dispersion, however, the plume of contaminants may move at a faster rate than the ambient groundwater and may arrive at given destinations more quickly than calculated above. A literature search has indicated that the dissolved solute phase of the contaminants will not be significantly affected by sorption, volatilization, chemical activity, or biodegradation. Because of the preliminary nature of the investigation, many questions relating to the extent of contamination remain unanswered. A list of suggested additional studies to answer those ques-

tions and to refine and confirm the findings of this investigation is presented. (Author's abstract)
W89-04943

RECONNAISSANCE OF HYDROLOGY, LAND USE, GROUND-WATER CHEMISTRY, AND EFFECTS OF LAND USE ON GROUND-WATER CHEMISTRY IN THE ALBUQUERQUE-BELEN BASIN, NEW MEXICO,
Geological Survey, Albuquerque, NM. Water Resources Div.
S. K. Anderholm.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4174. 1987. 37p, 13 fig, 1 tab, 31 ref, 1 plate in pocket.

Descriptors: *Water pollution sources, *Groundwater pollution, *Land use, *Water chemistry, *New Mexico, Groundwater recharge, Grazing, Cattle, Iron, Waste disposal, Effluents.

In 1984, the U.S. Geological Survey began regional assessments of groundwater contamination in 14 areas, one of which was the Albuquerque-Belen basin. Groundwater recharge occurs along the basin margins. Groundwater discharge occurs as evapotranspiration in the Rio Grande valley, pumpage, and groundwater flow to the Socorro basin. Open-space land use, which primarily is used for grazing livestock, occupies the majority of the basin. In the Rio Grande valley, agricultural and residential land uses are predominant; in the area near Albuquerque, the land also is used for commercial, institutional, and industrial purposes. The Albuquerque-Belen basin was divided into seven zones on the basis of water chemistry. These water-chemistry zones indicate that large variations in water chemistry exist in the basin as the result of natural processes. Groundwater in the majority of the Albuquerque-Belen basin has a relatively low susceptibility to contamination because the depth to water is $>$ 100 ft and there is virtually no natural mechanism for recharge to the groundwater system. Groundwater in the Rio Grande valley has a relatively high susceptibility to contamination because the depth to water is generally $<$ 30 ft and there are many types of recharge to the groundwater system. Changes in land use may cause changes in the chemical composition of recharge to the groundwater system. The relatively large concentrations of dissolved iron in the Rio Grande valley near Albuquerque may result from the change from agricultural land use to residential land use. Recharge associated with agricultural land use is relatively oxidized because the water is in equilibrium with the atmosphere, whereas recharge associated with residential land use (onsite waste-disposal effluent) is relatively reduced and has larger concentrations of organic carbon, biological oxygen demand, and chemical oxygen demand. The constituents in the onsite waste-disposal effluent could cause reducing conditions in the aquifer and the subsequent dissolution of iron and manganese oxides. Trace metals adsorbed to these iron and manganese oxides could be remobilized in groundwater after dissolution of the oxides. (Author's abstract)
W89-04944

SHALLOW GROUND-WATER CONDITIONS, TOM GREEN COUNTY, TEXAS,
Massachusetts Inst. of Tech., Cambridge. Microsystems Technology Labs.
For primary bibliographic entry see Field 2F.
W89-04947

LONG-TERM WATER-QUALITY CHARACTERISTICS OF CHARLOTTE HARBOR, FLORIDA,
Geological Survey, Tallahassee, FL. Water Resources Div.
T. H. Fraser.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4180, 1986. 43p, 20 fig, 15 tab, 15 ref.

Descriptors: *Charlotte Harbor, *Water pollution sources, *Harbors, *Pollutant identification, *Water quality, *Florida, Seasonal variation, Orthophosphates, Dissolved oxygen, Nitrogen compounds.

Water-quality data for nine constituents collected from January 1976 through March 1984 in upper Charlotte Harbor were examined for evidence of trend (change) with time. Average seasonal patterns and moving averages were described to aid initial descriptions of variation. Multilinear regression models were developed using independent variables that are known to or that may affect variation of constituent. A nonparametric analysis (Seasonal Kendall test) was used as a different approach to determine trends. These results were generally consistent with the parametric analyses. Evidence suggested an increasing trend for temperature and orthophosphate and a decreasing trend for near-surface dissolved oxygen. The temperature trend was related to low winter temperatures early in the period. The orthophosphate trend was related to a major source, the Peace River. The source of the dissolved oxygen trend was not identified, but a relation with primary producers (phytoplankton) was likely. Evidence of a trend was not found for total phosphate, reactive silica, and organic nitrogen. Trend analysis for chloride appeared complicated by strong serial correlation, and the tentative conclusion was that no trend occurred. Nitrate plus nitrite and ammonia data contained too many values that were less than detection limits, and trend analysis could not be made. (Author's abstract)
W89-04950

ASSESSMENT OF GROUND-WATER CONTAMINATION AT WURTSMITH AIR FORCE BASE, MICHIGAN, 1982-85,
Geological Survey, Lansing, MI. Water Resources Div.
T. R. Cummings, and F. R. Twenter.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4188, 1986. 110p, 3 plates, 55 fig, 16 tab, 10 ref.

Descriptors: *Groundwater pollution, *Path of pollutants, *Chlorinated hydrocarbons, *Jet fuel, *Michigan, Benzene, Cleanup, Trichloroethylene, Dichloroethylene.

Study of ground-water contamination at Wurtsmith Air Force Base, Michigan, defined the movement and distribution of volatile organic compounds in the glacial sand and gravel aquifer at known sites of contamination, and has defined new plumes at two other sites. The Arrow Street purge system, installed in 1982 to remove contaminants from the Building 43 plume, has lowered concentrations of trichloroethylene (TCE) in groundwater in the central part of the most contaminated area from a range of 1,000 to 2,000 microg/L to about 200 microg/L. TCE is not escaping off-Base from this area. In the southern part of the Base a plume containing principally TCE and dichloroethylene (DCE) has been delineated along Mission Drive. Maximum concentrations observed were 3,290 microg/L of TCE and 1,480 microg/L of DCE. Hydrologically suitable sites for purge wells were identified in the southern part of the plume using a new ground-water flow model of the Base. A benzene plume near the bulk-fuel storage area has shifted to a more northerly direction under influence of the Arrow Street purge system. Sites initially identified for purging the benzene plume have been repositioned because of the change in contaminant movement. JP-4 fuel was found to be accumulating in wells near the bulk-fuel storage area, largely in response to seasonal fluctuations in the water-table. It is thought to originate from a spill that occurred several years ago. In general, concentrations found in water do not differ greatly from those observed in 1981. Since 1981, concentrations of TCE have decreased significantly in the Alert Apron plume. Near the origin of the plume, the concentration of TCE has decreased from 1,000 microg/L in 1980 to 50 microg/L in 1984. Water from Van Etten Lake near the termination of the plume had only a trace of TCE at one site. Benzene detected in water from well AF2 seems to originate near the former site of buried fuel tanks west of the operational apron. During periods of normal purge pumping along Arrow Street, contaminants are drawn toward water-supply wells AF2, AF4, and AF5. (Author's abstract)
W89-04953

CHEMICAL EFFECTS OF HIGHWAY RUNOFF ON THE SURFICIAL AQUIFER, BROWARD COUNTY, FLORIDA,
Geological Survey, Tallahassee, FL. Water Resources Div.
B. Howie, and B. G. Waller.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4200, 1986. 41p, 4 fig, 9 tab, 16 ref.

Descriptors: *Highway runoff, *Water pollution sources, *Storm runoff, *Unconfined aquifers, *Path of pollutants, *Trace Metals, Swales, Iron, Lead, Zinc, Nitrogen, Phosphorus, Calcium carbonate, Florida.

In many areas of Broward County, swales are commonly designed to accept stormwater runoff from highways. Two sites adjacent to heavily traveled highways were studied to determine if stormwater percolating through unsaturated sand underlying the swales may affect the quality of water in the Biscayne aquifer. Concentrations of selected chemicals common in highway runoff were measured in swale stormwater, in the unsaturated-zone percolate, and in the surficial aquifer during 12 storms, May through November 1983. Analyses of the unsaturated lithologic material at the two sites and one control site were also made to indicate the extent of vertical attenuation of selected chemical constituents. Results of trace metal nutrient analyses indicated that there is no obvious water-quality effect on the surficial aquifer caused by highway runoff. In general, the data collected for dissolved trace metals indicated slight concentrations in stormwater samples with subsurface water samples usually indicating decreases in concentration below about 0.5 to 1 ft of unsaturated material. For most trace metals, the apparent decreases with depth were statistically significant based on nonparametric analysis of variance. Concentrations of dissolved nitrogen and phosphorus, however, were somewhat homogeneous and were not inferred to be significantly different with depth. Water hardness as calcium carbonate at both sites indicated a significant difference with depth because of calcium carbonate solution, but the effect of percolate hardness on the shallow groundwater was negligible because of regional mixing. The analyses of lithologic material at the two test sites indicated significant near-surface accumulation of some trace elements. For example, in the first foot below land surface, concentrations of iron, lead, and zinc were detected in the 1 to 7 mg/kg range, with concentrations decreasing sharply at lower depths. This near-surface accumulation was not indicated in the lithologic material at the control site. (Author's abstract)
W89-04962

WATER QUALITY OF THE MALHEUR LAKE SYSTEM AND MALHEUR RIVER, AND SIMULATED WATER-QUALITY EFFECTS OF ROUTING MALHEUR LAKE WATER INTO MALHEUR RIVER, OREGON, 1984-85,
Geological Survey, Portland, OR. Water Resources Div.
L. A. Fuste, and S. W. McKenzie.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4202, 1987. 74p, 29 fig, 25 tab, 22 ref.

Descriptors: *Oregon, *Malheur River, *Water pollution sources, *Water quality, *Storm runoff, *Simulation analysis, *Irrigation effects, *Salinity, Thermal springs, Seasonal variation, Arsenic, Boron, Rivers, Lakes.

Above average precipitation and runoff between 1980 and 1985 have raised the water-surface elevation of Harney, Mud, and Malheur Lakes in eastern Oregon to the highest levels recorded and have caused mixing and interflow of water among the

three lakes. A 50% increase in specific conductance throughout Malheur Lake from 1984 to 1985 resulted from an increase in sodium and chloride concentrations, probably caused by the flow of saline water from Harvey Lake and dissolution of evaporites in flooded areas around it. Arsenic and boron concentrations increased during the two years. Algal productivity was highest towards the center of Malheur Lake. Concentrations of major ions in the Malheur River during the 1985 irrigation season were dilute in upstream reaches because of flow releases from reservoirs; increasing in a downstream direction because of irrigation-return flow. Concentrations also increased with time during irrigation season, with the highest concentrations occurring in October after most diversions for irrigation were discontinued. Mass-balance equations were used to simulate mixing of Malheur Lake with Malheur River water to estimate the water quality that would occur at different points along Malheur River. Simulations of sodium and chloride concentrations and specific conductance values based on August river-flows during irrigation season, show a gradual increase from the headwaters downstream to Hope and greater increases downstream of Hope. After irrigation ceases, the simulated water quality becomes uniform throughout the river, because proposed lake flows are then the principal source of Malheur River flows. Arsenic and boron concentrations increase much more than expected between Namorf and Little Valley; thermal springs could be the source of arsenic and boron in this reach. Groundwater coming in contact with arsenic rich soils may also contribute to the elevated arsenic levels found in the river. At the end of the irrigation season, arsenic concentrations were measured at 85 microg/L in this 12-14 mi reach. Increasing inflows from Malheur Lake Should reduce arsenic levels between Namorf and the mouth, especially after irrigation ceases. (Author's abstract)
W89-04963

STREAMFLOW AND WATER QUALITY OF THE GRAND CALUMET RIVER, LAKE COUNTY, INDIANA, AND COOK COUNTY, ILLINOIS, OCTOBER 1984,
Geological Survey, Indianapolis, IN. Water Resources Div.
C. G. Crawford, and D. J. Wangsness.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4208, 1987. 137p, 65 fig, 15 tab, 25 ref.

Descriptors: *Water pollution sources, *Illinois, *Indiana, *Grand Calumet River, *Chemical wastewater, *Water quality, *Industrial wastes, *Municipal wastes, Effluents, Pollutant identification, Biochemical oxygen demand, Dissolved solids, Dissolved oxygen, Suspended solids, Ammonia, Nitrates, Nitrites, Phosphorus, Chlorides, Cyanide, Fluorides, Mercury.

A diel (24-hour) water-quality survey was done to investigate the sources of dry-weather waste inputs attributable to other than permitted point-source effluent and to evaluate the waste-load assimilative capacity of the Grand Calumet River, Lake County, Indiana, and Cook County, Illinois, in October 1984. Flow in the Grand Calumet River consists almost entirely of municipal and industrial effluents which comprised more than 90% of the 500 cu ft/sec flow observed at the confluence of the East Branch Grand Calumet River and the Indiana Harbor Ship Canal during the study. At the time of the study, virtually all of the flow in the West Branch Grand Calumet River was municipal effluent. Diel variations in streamflow of as much as 300 cu ft/sec were observed in the East Branch near the ship canal. The diel variation diminished at the upstream sampling sites in the East Branch. In the West Branch, the diel variation in flow was quite drastic; complete reversals of flow were observed at sampling stations near the ship canal. Average dissolved-oxygen concentrations at stations in the East Branch ranged from 5.7 to 8.2 mg/L and at stations in the West Branch from 0.8 to 6.6 mg/L. Concentrations of dissolved solids, suspended solids, biochemical-oxygen demand, ammonia, nitrite, nitrate, and phosphorus were substantially higher in the West Branch than in the East Branch. In the East Branch, only the Indiana Stream Pollution Control Board water-quality standards for total phosphorus and phenol were exceeded. In the West Branch, water-quality standards for total ammonia, chloride, cyanide, dissolved solids, fluoride, total phosphorus, mercury, and phenol were exceeded and dissolved oxygen was less than the minimum allowable. Three areas of significant differences between cumulative effluent and instream chemical-mass discharges were identified in the East Branch and one in the West Branch. The presence of unidentified waste inputs in the East Branch were indicated by differences in the chemical-mass discharges at three sites. Elevated suspended solids, biochemical-oxygen demand, and ammonia chemical-mass discharges at Columbia Avenue indicated the presence of a source of what may have been untreated sewage to the West Branch during the survey. (Author's abstract)
W89-04965

TRACE ELEMENT STUDIES IN A REMOTE SCOTTISH UPLAND CATCHMENT: I. CHEMICAL COMPOSITION OF SNOW AND MELTWATERS,
University of East Anglia, Norwich (England). School of Environmental Sciences.
P. W. Abrahams, M. Tranter, T. D. Davies, I. L. Blackwood, and S. Landsberger.
Water, Air, and Soil Pollution WAPLAC, Vol. 37, No. 3-4, p 255-271, February 1988. 2 fig, 9 tab, 56 ref.

Descriptors: *Chemistry of precipitation, *Acid rain, *Acid snow, *Snow, *Water pollution sources, *Trace elements, *Scotland, *Snowmelt, Catchment areas, Snow sampling, Path of pollutants, Cadmium, Manganese, Runoff.

Fresh and aged within-pack snow samples were collected and analyzed for 6 trace elements during the winters of 1984 and 1985 at a remote site located within the Cairngorm Mountains, Scotland. All of the fresh snow samples were acidic and highly variable in composition. The variability of pH and trace-element concentrations of snowfall are demonstrated to be associated with different air trajectory categories, and the study catchment is susceptible to episodic pollution events due to long range atmospheric transport. Partial melt experiments have shown that both fractionation and preferential elution of trace elements occur during melting, the concentrations being 1.3 to 5.4 times higher in the first 10% meltwater fraction than in the bulk snow. Cadmium and manganese appear to be preferentially eluted from the melting snow with respect to the remaining elements. Upon snowpack melting, the trace elements may be mobilized and redistributed within the snow profile. The ions concentrate at depth from where they can be quickly removed with the early water runoff during the spring. (Author's abstract)
W89-04971

CONCENTRATIONS OF TRACE ELEMENTS IN YELLOW PERCH (PERCA FLAVESCENS) FROM SIX ACIDIC LAKES,
Rutgers - The State Univ., New Brunswick, NJ. Center for Coastal and Environmental Studies.
For primary bibliographic entry see Field 5C.
W89-04977

POLLUTION OF GROUND WATER BY NUTRIENTS AND FECAL COLIFORMS FROM LAKESHORE SEPTIC TANK SYSTEMS,
New York State Dept. of Health, Albany. Wadsworth Center for Labs. and Research.
M. Chen.
Water, Air, and Soil Pollution WAPLAC, Vol. 37, No. 3-4 p 407-417, February 1988. 1 fig, 5 tab, 28 ref.

Descriptors: *Water pollution sources, *Path of pollutants, *Groundwater pollution, *Nutrients, *Septic Tanks, *Lake shores, *Coliforms, Fecal coliforms, Phosphate, Chloride, Nitrogen, Dissolved oxygen, Conductivity, Effluents, Wastewater.

The fate of wastewater effluents discharged from 17 septic tank disposal systems located near the shores of eight lakes in northeastern New York State was investigated. Fecal coliforms, chloride, conductivity, dissolved O2, phosphate and various forms of N in ground water samples were analyzed. Of 46 ground water samples, 23 were found to be highly contaminated and 16 were found to be slightly contaminated. Only 7 were not contaminated by the wastewater effluent. Seventeen of the 23 highly contaminated samples were collected within 30.5 m of the discharge point of the septic systems. Eleven of these were collected from ground water less than 122 cm below ground level. Eight of the 16 slightly contaminated samples and 3 of the 7 noncontaminated samples were collected at a distance greater than 30.5 m. The depth to the ground water from ground surface and the distance of the ground water from the discharge point of the sewage system are main factors influencing pattern and severity of ground water contamination. It was indicated that significant nutrient and fecal coliform contamination of lakeshore ground water was occurring. (Author's abstract)
W89-04978

BEHAVIOR OF SELECTED CHLORINATED ORGANIC MICROPOLLUTANTS IN THE ACTIVATED SLUDGE PROCESS: A PILOT PLANT STUDY,
Rentokil Ltd., East Grinstead (England). Research and Development Div.
R. S. K. Buisson, P. W. W. Kirk, and J. N. Lester.
Water, Air, and Soil Pollution WAPLAC, Vol. 37, No. 3-4 p 419-432, February 1988. 7 tab, 55 ref.

Descriptors: *Activated sludge process, *Wastewater treatment, *Pilot plants, Degradation, Micropollutants, chlorinated hydrocarbons, Lindane, Dieldrin, Polychlorinated biphenyls, DDE, Phenols.

An activated sludge pilot plant was operated at 4, 6 and 9 d sludge ages with influent settled sewage from a full scale treatment works. The behavior of the chlorinated organic micropollutants was examined at their background levels by analysis of influent settled sewage, mixed liquor and effluent by gas chromatographic methods. Highly significant removal at all sludge ages in terms of the reduction in micropollutant concentration in influent sewage to final effluent was observed for dieldrin, polychlorinated biphenyls, 4-chloro-e-methylphenol (4-C-3 MPol) and dimethylphenol. Significant removal at some sludge ages was observed for gamma-lindane (gamma-HCH), DDE, pentachlorophenol and 2,4-Dichlorophenol. Calculated mass balances indicated that removal of gamma-HCH, polychlorinated biphenyls, and DDE was by adsorption onto mixed liquor suspended solids rather than by air stripping or a degradative process. A comparison of the effluents from the activated sludge tanks run at 4 and 9 d sludge age with the same influent settled sewage indicated that significantly higher concentrations of pentachlorophenol, 2,3,4,6-tetrachlorophenol, 2,4,6-trichlorophenol, and 4-C-2-methylphenol were seen in the effluent from the unit at 4 d sludge age. The effluent from the 9 d sludge age tank had significantly higher concentrations of dieldrin, gamma-HCH and 4-C-3-MPol. Significant biological degradation was concluded to have taken place for 4-C-3-MPol and pentachlorophenol since they exhibited poor association with sludge solids and on theoretical grounds are unlikely to be removed by air stripping. (Author's abstract)
W89-04979

EFFECT OF SEDIMENT PH AND OXIDATION-REDUCTION POTENTIAL ON PCB MINERALIZATION,
Louisiana State Univ., Baton Rouge. Lab. for Wetland Soils and Sediments.
J. H. Purdue, R. D. Delaune, and W. H. Patrick.
Water, Air, and Soil Pollution WAPLAC, Vol. 37, No. 3-4 p 439-447, February 1988. 5 fig, 23 ref.

Descriptors: *Fate of pollutants, *Polychlorinated biphenyls, *Biodegradation, *Mineralization, *Hydrogen ion concentration, *Oxidation-reduction

potential, *Lake sediments, Aerobic conditions, Sediment, Louisiana, Radiochemical studies, Anaerobic conditions, Microbial degradation.

Microbial mineralization rates of 14C-labelled polychlorinated biphenyl (PCB) mixture were determined in PCB-contaminated Capitol Lake, LA, sediment under controlled pH and redox conditions. Mineralization rates were inferred from the activity of 14CO2 evolved from the sediment suspensions. Sediment pH and redox potential significantly affected PCB mineralization. Mineralization rates were higher under moderately aerobic conditions (microaerophilic) (+250 mV) than under aerobic conditions (+500 mV) or anaerobic conditions (0 mV and -200 mV). PCB mineralization rates in moderately aerobic sediment were 30 to 40 fold higher than those in anaerobic sediment. Sediment conditions in the oxidized surface layer would promote PCB mineralization. Sediment pH and redox potential were shown to be two sediment parameters which can be managed to enhance degradation of PCBs in contaminated sediment. (Author's abstract)
W89-04980

MOBILIZATION OF CU AND ZN IN CONTAMINATED SOIL BY NITRILOTRIACETIC ACID,
Pennsylvania State Univ., University Park. Dept. of Agricultural Engineering.
J. H. Linn, and H. A. Elliott.
Water, Air, and Soil Pollution WAPLAC, Vol. 37, No. 3-4 p 449-458, February 1988. 4 fig, 2 tab, 31 ref.

Descriptors: *Path of pollutants, *Soil contamination, *Soil chemistry, *Copper, *Zinc, *Nitrilotriacetic acid, *Chelation, Heavy metals, Solubility, Leaching, Soil columns, Solute transport.

Batch and upflow column leaching experiments were used to evaluate the nature and extent of Cu and Zn solubilization from contaminated soil by nitrilotriacetic acid in 0.025 M NaClO4. In batch soil suspensions, nitrilotriacetic acid levels of 0.00001 to 0.001 M substantially promoted Cu and Zn release from the metal-enriched soil. The ability of nitrilotriacetic acid to enhance Cu and Zn solubility decreased with increasing solution acidity probably due to competitive binding of nitrilotriacetic acid by protons and Fe released by hydrous oxide dissolution. However, in the pH range typically encountered in northeastern U.S. soils, soluble metal levels were nearly constant for a given nitrilotriacetic acid concentration. Leaching soil columns with nitrilotriacetic acid solutions enhanced Cu release more than Zn, as the enrichment ratio after 85 pore volumes displacements was 23.6 and 4.3 for Cu and Zn, respectively. While Cu release by 0.01 M CaCl2 differed a little from the control, 0.01 M CaCl2 was substantially more effective than 0.00001M nitrilotriacetic acid in displacing bound Zn. The data reflect different retention mechanisms for Cu and Zn in this soil. Differences in the desorption behaviors of Cu and Zn arise from alternate metal retention modes within contaminated soils. In the soil studied, a larger proportion of Zn was present in a readily exchangeable form so that leaching with 0.01 M CaCl2 substantially enhanced Zn release, probably because of the more stable Cu-nitrilotriacetic acid complex. The results underscore the need to understand both the metal solution chemistries and the metal distribution among various modes of fixation within the soil in evaluating the impact of nitrilotriacetic acid on metal solubilization in soils. (Miller-PTT)
W89-04981

FACTS AND FALLACIES CONCERNING MERCURY UPTAKE BY FISH IN ACID STRESSED LAKES,
Toronto Univ. (Ontario). Inst. for Environmental Studies.
For primary bibliographic entry see Field 5C.
W89-04982

AMBIENT CONCENTRATION AND PRECIPITATION SCAVENGING OF ATMOSPHERIC ORGANIC POLLUTANTS,
Texas A and M Univ., College Station. Dept. of Oceanography.
For primary bibliographic entry see Field 2B.
W89-04983

INTRA-URBAN PRECIPITATION QUALITY: HAMILTON, CANADA,
McMaster Univ., Hamilton (Ontario). Dept. of Geography.
S. J. Vermette, J. J. Drake, and S. Landsberger.
Water, Air, and Soil Pollution WAPLAC, Vol. 38, No. 1-2, p 37-53, March 1988. 8 fig, 4 tab, 21 ref.

Descriptors: *Precipitation, *Water quality, *Canada, *Acid rain, *Urban hydrology, Halogens, Heavy metals, Sulfur, Hydrogen ion concentration, Water pollution sources.

Intra-urban variability of H(+) (as measured by pH) along with S, halogens and heavy metals, are studied in bulk precipitation from a network of 11 collectors located in the city of Hamilton, Canada. Bulk precipitation is shown to be a useful indicator of both elemental intra-urban variability and sources. Precipitation acidity is an order of magnitude less within urban areas than of that measured outside the city. bulk depositional characteristics are classified into three distinct patterns as influenced by industrial emissions (Cu, Cl, Fe, Mn, and V), urban sediments (Ca and Mg), and automobile emissions (Br and Pb). A substantial component of S and Zn loadings are attributed to anthropogenic sources from outside the city while a substantial component of Al, I and Na loadings are attributed to natural sources. (Author's abstract)
W89-04984

IMPACT OF AFFORESTATION ON THE SOIL SOLUTION CHEMISTRY OF STAGNOPODZOLS IN MID-WALES,
Institute of Terrestrial Ecology, Bangor (Wales). Bangor Research Station.
For primary bibliographic entry see Field 2G.
W89-04985

ALKALINITY DESTRUCTION BY SEDIMENT ORGANIC MATTER DISSOLUTION DURING NEUTRALIZATION OF ACIDIFIED LAKES,
Cornell Univ., Ithaca, NY. Dept. of Environmental Engineering.
J. J. Bisogni, and S. A. Kishbaugh.
Water, Air, and Soil Pollution WAPLAC, Vol. 38, No. 1-2, p 85-95, March 1988. 4 fig, 3 tab, 19 ref.

Descriptors: *Lake sediments, *Acidic lakes, *Lake restoration, *Path of pollutants, *Acidification, *alkalinity, *Organic matter, Equilibrium, Ion exchange, Isotherms, Fulvic acids, Humic acids, Solubility, Sediment transport.

Neutralizing agent-sediment interactions were studied using sediment from an acidified lake. This lake was subsequently neutralized with NaHCO3; therefore, sediment interactions were studied specifically for the case in which Na was the cation added. Since Na-sediment exchange is minimal, the specific objective was to determine and quantify sediment interactions other those of the ion exchange type. Based on the results of laboratory equilibrium studies, several conclusions can be made. The affinity of Na for sediment from acid lakes is probably fairly low, but some ion exchange with H(+) has been observed. This exchange is a function of pH and aqueous Na concentration. An empirical isotherm relationship was developed to describe the exchange process. Na exchange for H(+) or acid metal ions does not account for all the alkalinity destruction observed during the neutralizing process. Dissolution of sediment organic matter (presumably fulvic and humic acids) during neutralization of acid lakes may be responsible for significant destruction of alkalinity as measured by the Gran plot technique. This destruction of measured alkalinity is a consequence of the inability of the Gran plot technique to fully protonate the weak humic and fulvic acids. Protons that are left in solution from the dissociated weak acids deplete measured (Gran plot) alkalinity. (Miller-PTT)
W89-04987

ACCUMULATION OF HG AND CR BY THREE AQUATIC SPECIES AND SUBSEQUENT CHANGES IN SEVERAL PHYSIOLOGICAL AND BIOCHEMICAL PLANT PARAMETERS,
Darjeeling Government Coll. (India). Dept. of Botany.
S. Jana.
Water, Air, and Soil Pollution WAPLAC, Vol. 38, No. 1-2, p 105-109, March 1988. 3 tab, 10 ref.

Descriptors: *Aquatic Plants, *Bioaccumulation, *Water pollution effects, *Path of pollutants, *Mercury, *Chromium, *Biochemistry, Physiological ecology, Accumulation, Heavy metals, Tolerance, Plant physiology, Enzymes.

Accumulation of Hg and Cr and subsequent changes in the physiological and biochemical parameters were studied in species of the aquatic genera, Eichhornia crassipes, Hydrilla verticillata and Oedogonium areolatum. Accumulation of Cr was highest in Eichhornia (10.21 micromol per g dry tissue wt), followed by Hydrilla (9.0) and Oedogonium (6.02); that of Hg was maximum in Hydrilla (4.21), followed by Oedogonium (3.35) and Eichhornia (2.79). Accumulation of Cr and Hg in roots of Eichhornia was about twelve and two times higher, respectively, than in shoots of the genus. Higher accumulations of Cr than that of Hg in the aquatics was observed. In general, Cr (0.00001923 M) and Hg (0.00000498 M) did not show significant changes over control in the following parameters: (1) Hill activity, chlorophyll, protein, free amino acid, inorganic phosphorus, ribonucleic acid, deoxyribonucleic acid, dry wt, permeability, the activities of protease, RNase, catalase and peroxidase, and acid; and (2) alkaline pyrophosphatase activity in the three aquatic plants. The plant species have tolerance capacity to the heavy metals applied. (Author's abstract)
W89-04989

TOTAL CADMIUM CONCENTRATIONS IN THE WATER AND LITTORAL SEDIMENTS OF CENTRAL ONTARIO LAKES,
Guelph Univ. (Ontario). Dept. of Zoology.
M. Stephenson, and G. L. Mackie.
Water, Air, and Soil Pollution WAPLAC, Vol. 38, No. 1-2, p 121-136, March 1988. 4 fig, 7 tab, 26 ref.
NSERC Grant no. G0918.

Descriptors: *Cadmium, *Lake sediments, *Littoral zone, *Ontario, Canada, Acidic water, Heavy metals, Acidic lakes, Watersheds, Multivariate analysis, Hydrogen ion concentration, Fluorides, Aluminum, Bottom sediments.

Total Cd concentrations in the surface waters and littoral sediments of central Ontario lakes are reported. Lakes were grouped within the central Ontario region to test for local areas of high Cd concentrations. Correlations between Cd concentrations in water and sediments, and other physical and chemical environmental parameters are explored using a multivariate (principal components analysis and multiple regression) approach. Lakes within 20 km of Sudbury, Ontario have significantly higher Cd concentrations in surface waters (geometric mean 122 ng/L, n = 7) than lakes elsewhere in central Ontario (10.8 ng/L, n = 57). Cadmium concentrations in water from lakes beyond Sudbury halo were negatively correlated with pH. A weak correlation between fluoride and Cd concentrations leads to speculation that some Cd may be mobilized from watersheds with Al. Cadmium concentrations in littoral sediments are not elevated near Sudbury. The geometric mean Cd concentration of littoral sediments in central Ontario lakes is 0.08 mg Cd per kg dry mass (n = 75). Cadmium concentrations in littoral sediments are strongly correlated with sediment loss on ignition. After correction for differences in organic content, littoral sediments are less enriched with Cd than profundal sediments, as reported in the literature. The difference between littoral and profundal sediments, and the sensitivity of Cd concentrations in water to pH, may be due to the importance of Cd binding by Fe/Mn hydrous oxides in the profundal zone, while organic matter binds Cd in the littoral zone. The lack of sensitivity of Cd concentrations in littoral sediments to acidification

may be due to the incorporation of much of the Cd in those sediments into organic particulates. (Miller-PTT)
W89-04990

COMPARATIVE STUDY OF THE PRECIPITATION ACIDITY IN TWO CITIES IN CANTABRIA (SPAIN) WITH DIFFERENT DEGREES OF INDUSTRIALIZATION,
Cantabria Univ., Santander (Spain). Dept. of Fundamental Physics.
A. Bonet, N. Diaz-Caneja, I. Guiterrez, A. Martinez, and E. Villar.
Water, Air, and Soil Pollution WAPLAC, Vol. 38, No. 1-2, p 181-188, March 1988. 1 fig, 3 tab, 17 ref.

Descriptors: *Air pollution effects, *Water pollution sources, *Industrial development, *Acid rain, *Spain, *Precipitation, *Fate of pollutants, Hydrogen ion concentration, Comparison studies, Urban areas, Statistical analysis.

The results obtained from the study of the pH value of bulk precipitation samples, collected at two sites with different degrees of industrialization, were analyzed. The possible influence of local pollution and of both long-range and mid-range transport of pollutants is discussed. The study was carried out simultaneously in two cities, Santander and Torrelavega, in Cantabria (Spain) over a period of one year. Santander is a commercial and residential city in the service sector and Torrelavega has a marked industrial character and a great deal of traffic owing to the fact that two national highways with high-density traffic meet there. It was observed that the annual weighted average values for the pH of precipitation, 4.42 and 4.21, respectively, differ significantly although the difference is less than that existing between their pollution levels. The difference is greater when total annual H(+) depositions are compared. The study also demonstrated the strong influence of long-range transport effect on acidity and to a lesser degree the effect of mid-range transport. (Miller-PTT)
W89-04991

SOME FEATURES OF A BLOOM OF OSCILLATORIA RUBESCENS D.C. REGISTERED IN TWO ITALIAN RESERVOIRS,
Istituto Superiore di Sanita, Rome (Italy).
For primary bibliographic entry see Field 2H.
W89-04995

CHEMISTRY OF PRECIPITATION NEAR A LIMESTONE BUILDING,
Antwerp Univ., Wilrijk (Belgium). Dept. of Chemistry.
E. Roekens, Z. Komy, L. Leysen, P. Veny, and R. VanGrieken.
Water, Air, and Soil Pollution WAPLAC, Vol. 38, No. 3-4, p 273-282, April 1988. 1 fig, 4 tab, 19 ref. Commission of the European Community Grant EV3V-0928-V (GDF).

Descriptors: *Acid rain effects, *Weathering, *Chemistry of precipitation, *Limestone, *Calcium carbonate, *Rainfall, *Buildings, Heavy metals, Belgium, Air pollution, Hydrogen ion concentration, Calcium, Alkalinity, Neutralization, Trace elements.

A total of 82 samples of wet and total deposition were sampled near the limestone cathedral at Mechelen, Belgium, which is presently being affected seriously by air pollution, and at a reference site. Most of these samples were analyzed for 10 major and 7 trace ions in solution and for 15 elements in suspension. Wet (mean pH = 5.8) as well as total (mean pH = 6.7) deposition at the St. Rombouts cathedral have higher pH levels compared with the natural pH of rainwater (pH = 5.6) and total deposition in St. Kateljine-Waver (mean pH = 4.9). The concentration of Ca and total suspended particles in St. Kateljine-Waver is a factor 3.5 lower than in Mechelen whereas the other ions differ to a lesser extent between the two stations. The suspended particulate Ca concentration in total deposition is five times higher in Mechelen than in St. Kateljine-Waver. Hence, it might be concluded that the alkaline pH of deposition samples in Mechelen is due to neutralization of the rainwater by the washout of CaCO3 particles which originate from the erosion of the building and partially from the emission of the restoration workplace at the bottom. It thus appears that there is no direct attack on the stone of acids in rainwater. The trace element levels are not significantly different between both sampling sites. The Zn, Cd, Pb, and Cu levels are comparable with those reported in other countries. (Miller-PTT)
W89-04996

CHEMICAL DEPOSITION OF A HIGH ELEVATION RED SPRUCE FOREST,
Tennessee Valley Authority, Muscle Shoals, AL.
S. F. Mueller, and F. P. Weatherford.
Water, Air, and Soil Pollution WAPLAC, Vol. 38, No. 3-4, p 345-363, April 1988. 8 fig, 3 tab, 15 ref. EPA Cooperative Agreement 813-934010.

Descriptors: *Deposition, *Forests, *Spruce trees, *Acid rain, *Water pollution sources, Ozone, Sulfates, Virginia, Nitrates.

A preliminary analysis of O3, SO2, SO4(-2), and total NO3(-) deposition to the red spruce forest on the summit of Whitetop Mountain, Virginia, illustrates uncertainties in analysis methodologies, establishes the relative importance of three deposition pathways, and suggests areas for further research. Results are presented for an analysis of the dry, wet (precipitation) and cloud water deposition pathways for the four chemical species during a 26-day period in April and May 1986. Dry and cloud water depositions are estimated using available models along with air and cloud water chemistry measurements made at the summit. For water soluble species, depositions by precipitation and cloud interception are comparable in magnitude, while dry deposition appears to be about an order of magnitude less. High levels of atmospheric O3 lead to a large estimate of O3 deposition (on a mass flux basis) when compared to the estimated deposition of gaseous SO2. This occurred in spite of the fact that computed SO2 dry deposition velocities exceed those for O3. Model uncertainties are large for both dry deposition velocity and cloud water flux computations, and some bias in computations probably exists because of the application of the models to a complex terrain situation. Field evaluation of the cloud water deposition model is of greatest priority because of the apparent relative importance of that deposition pathway. (Author's abstract)
W89-04999

EFFECT OF SIMULATED ACID RAIN ON NITROGENASE ACTIVITY IN THE LICHEN GENUS PELTIGERA UNDER FIELD AND LABORATORY CONDITIONS,
Aquatic Habitat Inst., Richmond, CA.
A. J. Gunther.
Water, Air, and Soil Pollution WAPLAC, Vol. 38, No. 3-4, p 379-385, April 1988. 2 fig, 21 ref.

Descriptors: *Water pollution sources, *Acid rain effects, *Lichens, *Simulated rainfall, Acetylene reduction, Chemistry of precipitation, Alaska, Hydrogen ion concentration, Nitrogenase.

Lichens of the genus Peltigera were exposed to simulated acid rain in the laboratory and at a field site in Southwestern Alaska. Exposure to simulated rainfall of pH 4.4 had no effect upon acetylene reduction in P. rufescens after experiments of 28 and 60 days duration, although in the former experiment there was some evidence of a transient effect after 14 days. Simulated acid rain of pH 3.4 or 4.4 also had no effect upon nitrogenase activity in P. aphthosa during a 21-day field study, indicating that nitrogenase activity in Peltigera is not sensitive to precipitation in this range of acidity. (Author's abstract)
W89-05001

BORON CONTENT IN FRESHWATERS OF NORTHERN ITALY,
Istituto di Ricerca sulle Acque, Brugherio (Italy). Reparto Sperimentale di Idrobiologia Applicata.
G. Tartari, and M. Camusso.
Water, Air, and Soil Pollution WAPLAC, Vol. 38, No. 3-4, p 409-417, April 1988. 6 fig, 2 tab, 21 ref.

Descriptors: *Boron, *Italy, *Surface water, *Lakes, *Rivers, *Water pollution, *Pollutant identification, Water pollution sources, Fate of pollutants, Indicators, Irrigation water, Detergents, Phosphorus, Photometry.

The B concentration was determined in bulk deposition and in surface freshwaters (lakes and rivers) of the river Po watershed in Northern Italy. The curcumin photometric method was used to determine B content for all analyses. The B concentrations were under detection limits (0.06 mg B/L) in bulk deposition and below 0.09 mg B/L in lake waters. Most river samples examined (65%) showed values close to natural background content (below 0.1 mg B/L), except in two of the rivers intensely altered by polluted effluents, where the concentrations range from 0.1-0.5 mg B/L all along their courses. The results indicate that B content in lakes and rivers is strictly dependent on levels of their anthropogenic alteration. It tends to increase in lacustrine waters in relation to the trophic state, whereas in river waters its concentrations are influenced by the ratio of dilution of effluents. The relationship between the B content and both total dissolved P and anionic detergent concentrations emphasizes the role of domestic sources for this element; therefore, B, for its chemically peculiar characteristics, should be considered as an important index of surface water quality alteration. Even if it does not yet present an immediate toxicity risk for biota in the examined area, the use for irrigation few river water with elevated B content may soon constitute a hazard for more sensitive crops. (Miller-PTT)
W89-05002

USE OF ANILINE AS AN INDICATOR OF PERSISTENCE IN ENVIRONMENTAL STUDIES,
Lilly (Eli) and Co., Indianapolis, IN. Lilly Research Lab.
For primary bibliographic entry see Field 5A.
W89-05005

INFLUENCE OF UV RADIATION ON ORGANIC MATTER TRANSFORMATION AND SUBSEQUENT ALTERATION OF LEACHING AND TRANSPORT PROCESSES OF HEAVY METALS,
Rome Univ. (Italy). Dept. of Chemistry.
L. Campanella, E. Cardarelli, T. Ferri, B. M. Petronio, and A. Pupella.
Science of the Total Environment STENDL, Vol. 76, No. 1, p 41-48, September 15 1988. 4 fig, 2 tab, 12 ref.

Descriptors: *Sludge, *Waste disposal, *Fate of pollutants, *Water pollution sources, *Path of pollutants, *Ultraviolet radiation, *Leaching, Organic matter, Heavy metals, Degradation, Temperature effects.

The effect of ultraviolet radiation on urban sludge, including both organic matter and the related metal leaching processes, was studied. The results show that ultraviolet radiation determines both the degradation of macrostructures and the re-polymerization of degradation products. Nevertheless, these reactions do not seem to affect the leachability of metals strongly. Experiments performed with and without temperature control showed that temperature also plays an important role in the fate of metals in the environment. (Author's abstract)
W89-05009

TOTAL SELENIUM CONCENTRATION IN TAP AND BOTTLED DRINKING WATER AND COASTAL WATERS OF GREECE,
Patras Univ. (Greece). Dept. of Chemistry.
M. S. Bratakos, T. F. Zarifopoulos, P. A. Siskos, and P. V. Ioannou.
Science of the Total Environment STENDL, Vol. 76, No. 1, p 49-54, September 15 1988. 2 fig, 19 ref.

Descriptors: *Selenium, *Drinking water, *Coastal waters, *Greece, *Fluorometry, Water pollution, Tap water, Seasonal variations, Pollutant identification.

The total selenium concentration in various waters from all over Greece was determined fluorometrically. The concentration in most drinking water, either from the tap or bottled, was within the range 100-200 ng/L and showed no great seasonal fluctuation. Most Greeks receive 0.2-0.4 microg selenium per day from drinking water. Coastal surface water contains 100-250 ng selenium/L, while higher concentrations are found at locations regarded as polluted. (Author's abstract)
W89-05010

DIAZINON TOXICITY EFFECT ON PROTEIN AND NUCLEIC ACID METABOLISM IN THE LIVER OF ZEBRAFISH, BRACHYDANIO RERIO (CYPRINIDAE),
Gorakhpur Univ. (India). Dept. of Zoology.
For primary bibliographic entry see Field 5C.
W89-05011

PHOTOCHEMICAL DECOMPOSITION OF CARBAMATE PESTICIDES IN NATURAL WATERS OF NORTHERN GREECE,
Thessaloniki Univ., Salonika (Greece). Environmental Pollution Control Lab.
V. Samanidou, K. Fytianos, G. Pfister, and M. Bahadir.
Science of the Total Environment STENDL, Vol. 76, No. 1, p 85-92, September 15 1988. 4 fig, 4 tab, 22 ref.

Descriptors: *Fate of pollutants, *Chemical degradation, *Decomposition, *Pesticides, *Carbamate pesticides, *Greece, *River, *Lakes, *Seawater, *Photochemical degradation, Natural waters, Carbofuran, Carbaryl, Thiram.

The influence of different aqueous systems (rivers, lakes and seawater) on the photochemical decomposition of the carbamate pesticides carbofuran, carbaryl and thiram was investigated. The rate of degradation was measured with a high performance liquid chromatograph and with an ultraviolet detector at 205 nm for carbaryl and carbofuran, and at 215 nm for thiram. Degradation products were identified using flame ionization detector gas chromatography. Comparing the degree of degradation of the carbamates, it can be seen that it was greater under ultraviolet irradiation than exposure to sunlight for the same period, due to oxygenation of the samples. Carbofuran photolysis was faster than that of carbaryl or thiram. On the basis of the water systems examined, no distinct order of photodecomposition can be observed. The solubility of carbaryl in marine water was very much lower than in lake or river water probably because of the salt content. The high concentration of suspended matter in river and lake water influences the absorption of sunlight and, consequently, the degree of photodegradation of the carbamates. The carbamates examined degrade to a different degree under similar photochemical conditions, depending on the water system and the duration of irradiation. In most cases, the photodegradation products also show further degradation. (Miller-PTT)
W89-05014

DISPLACEMENT OF CHERNOBYL FALLOUT IN SNOW LAYERS OF TEMPERATE ALPINE GLACIERS,
Innsbruck Univ. (Austria). Inst. of Medical Physics.
W. Ambach, W. Rehwald, M. Blumthaler, H. Eisner, and P. Brunner.
Science of the Total Environment STENDL, Vol. 76, No. 2/3, p 101-107, October 15 1988. 4 fig, 1 tab, 7 ref.

Descriptors: *Snow sampling, *Glaciers, *Nuclear energy, *Radioactive wastes, *Fallout, *Path of pollutants, *Chernobyl, Alps, Radioactive half-life.

Measurements of the gross-beta-activity and a gamma-spectrum analysis of radioactive fallout from Chernobyl distributed in vertical snow profiles on an Alpine glacier were carried out. Samples were collected in summer 1986 and in summer 1987. A displacement of isotopes to depths of about 6 m was observed. The mean activity per unit area amounts to 10.4 and 6.6 kBq/sq m for samples from 1986 and 1987, respectively, with both values corrected to 1 May 1987. Isotopes with half-lives shorter than 110mAg (250 days) could no longer be detected in 1987. (Author's abstract)
W89-05015

TRIBUTYLTIN CONTAMINATION IN THE FIRTH OF FORTH (1975-87),
Napier Coll. of Commerce and Technology, Edinburgh (Scotland).
For primary bibliographic entry see Field 5C.
W89-05016

METHOD FOR DETERMINING METAL SPECIES IN SOIL PORE WATER,
Queen's Univ., Kingston (Ontario). Dept. of Chemistry.
For primary bibliographic entry see Field 5A.
W89-05017

LEACHING BEHAVIOR OF SELECTED TRACE ELEMENTS IN CHEMICALLY WEATHERED ALKALINE FLY ASH,
Alberta Univ., Edmonton. Dept. of Soil Science.
C. J. Warren, and M. J. Dudas.
Science of the Total Environment STENDL, Vol. 76, No. 2/3, p 229-246, October 15 1988. 4 fig, 3 tab, 35 ref. EPRI RP2485-01.

Descriptors: *Water pollution sources, *Waste disposal, *Industrial wastes, *Leaching, *Trace elements, *Fly ash, *Weathering, Alkalinity, Atomic absorption spectroscopy, Residual soils, Electric power industry.

In a laboratory study, alkaline fly ash was leached in a series of lysimeters with dilute H2SO4. The weathered residues retrieved after leaching were analyzed for major constituents by atomic absorption spectrophotometry and trace elements by instrumental neutron activation analysis. The characteristics of the weathered residues ranged from highly leached acidified material, from which many constituent elements had been mobilized, to minimally leached alkaline material containing accumulations of newly formed secondary minerals. The leaching behavior of constituent trace elements was related to the chemical environment of the leachates and partitioning among two previously identified major phases within parent ash particles and with newly found secondary minerals. Elements such as Rb, Cs, Pb, Ta, Ti and Hf were enriched in the highly leached portion of the residue sequence, suggesting association with the resistant internal Si-rich glass matrix of ash particles. Between 50 and 80% of the total Mn, Sb, Th, Cr, Zn, Co, Sc, and rare earth elements was also retained in the highly leached ash residues. About 50% of the total Sr, V, and U, and more than 80% of the total As and B was dissolved from the ash under acidic conditions. With the exception of B, all elements that were mobilized from the acidified ash residues were also attenuated in the alkaline residues in association with one or more of the newly formed secondary minerals. (Author's abstract)
W89-05018

PARTICLE SIZE AND CHEMICAL CONTROL OF AS, CD, CU, FE, MN, NI, PB, AND ZN IN BED SEDIMENT FROM THE CLARK FORK RIVER, MONTANA (U.S.A.),
Montana Univ., Missoula. Dept. of Geology.
E. J. Brook, and J. N. Moore.
Science of the Total Environment STENDL, Vol. 76, No. 2/3, p 247-266, October 15 1988. 5 fig, 5 tab, 41 ref. NSF Instrumentation Grant no. EAR-8606061.

Descriptors: *Path of pollutants, *Clark Fork River, *Mine wastes, *Metals, *Arsenic, *Pollutant identification, *Sediments, Cadmium, Copper, Iron, Manganese, Nickel, Lead, Zinc, Montana, River beds, Particle size.

The role of particle size as a control of metal and arsenic concentrations in river-bed sediment, and the chemical speciation of the large excess concentrations of metals and arsenic in this system, were studied. Mining and smelting in the headwaters of the Clark Fork River have significantly enriched Clark Fork River bed sediment in As, Cd, Cu, Mn, Pb, and Zn. These enriched elements are present predominantly in 'reducible' and 'oxidizable' chemical phases, with small contributions from 'residual' phases. In size fractionated samples (> 300, 300-63, 63-38, 38-17, and <17 microm) metals and arsenic concentrations generally increase with decreasing particle size, with the greatest contribution to this increase from the 'reducible' phase. Copper is an exception, with the strongest contribution to this increase from the 'oxidizable' phase. Anomalously high concentrations in the coarsest (> 300 microm) fraction of some of the samples described are due to preferential concentration of iron and manganese oxides on coarse particles, and entrapment of coarse organic material on 300 microm sieves. Clark Fork bed sediment is, in general, quite coarse; the relatively high concentrations of metals in the coarse fractions of these sediments are therefore important to the bulk metal and As content of this system. (Author's abstract)
W89-05019

RHOCO2 VARIATIONS IN STREAMWATERS DRAINING AN ACIDIC AND ACID SENSITIVE SPRUCE FORESTED CATCHMENT IN MID-WALES,
Institute of Hydrology, Wallingford (England).
C. Neal.
Science of the Total Environment STENDL, Vol. 76, No. 2/3, p 279-283, October 15 1988. 1 fig, 20 ref.

Descriptors: *Path of pollutants, *Streams, *Forests, *Wales, *Acidic water, *Acid rain, *Model studies, *Spruce trees, Catchment areas, Titration, Gran titration, Acidity, Alkalinity, Hydrogen ion concentration, Acidic soils.

Acidimetric and alkalimetric Gran titration data are presented for streams draining the Hafren forest in mid-Wales. Results show that the excess rhoCO2 (rhoCO2stream/rhoCO2air) varies approximately linearly with pH; values (range 1-7) typically varying between 4 and 2 times atmospheric pressure at pHs of 4.5 and 7.5, respectively. The superiority of the alkalimetric titration over that of the acidimetric titration is demonstrated. The results suggest that, for detailed process and modelling activities, alkalimetric titrations should be undertaken to maximize the information gained. From a process point of view the alkalimetric titration should have a much higher priority than the corresponding 'alkalinity' titration since much more reliable values are obtained. Within the modelling context, the results are important in that they demonstrate that the excess rhoCO2 varies as a function of pH. (Miller-PTT)
W89-05020

COLIPHAGES AND ENTERIC VIRUSES IN THE PARTICULATE PHASE OF RIVER WATER,
Institut Armand-Frappier, Laval (Quebec). Centre de Recherche en Virologie.
P. Payment, E. Morin, and M. Trudel.
Canadian Journal of Microbiology CJMIAZ, Vol. 34, No. 7, p 907-910, July 1988. 2 tab, 20 ref.

Descriptors: *Viruses, *Enteroviruses, Rivers, *Filtration, *Coliphages, Particulate matter, Water supply.

The question of whether or not indigenous enteric viruses and coliphages are free or associated with suspended particulate matter in natural water was addressed. River water was filtered on filters of decreasing porosities (100-0.25 microm) that were pretreated with detergent to eliminate viral adsorption while retaining particulates. This filtered water was refiltered in virus-absorbing conditions to retain free viruses. The virus-absorbing filter retained most of the enteric viruses (77.4%) and coliphages (65.8%), which indicated that these vi-

ruses were probably free or associated with particles with a diameter of less than 0.25 microm. These observations are important because, in water treatment plants, small particulates are often the most difficult to eliminate. (Author's abstract)
W89-05021

OCCURRENCE OF ENTEROVIRUSES IN MARINE SEDIMENT ALONG THE COAST OF BARCELONA, SPAIN,
Barcelona Univ. (Spain). Dept. of Microbiology.
A. Bosch, F. Lucena, R. Girones, and J. Jofre.
Canadian Journal of Microbiology CJMIAZ, Vol. 34, No. 7, p 921-924, July 1988. 1 fig, 4 tab, 19 ref.

Descriptors: *Enteroviruses, *Marine sediments, *Spain, *Water pollution sources, *Bacteria, Effluents, Streptococcus, Sediment, Correlation analysis, Wastewater pollution.

A survey of the occurrence of enteroviruses in marine sediment was undertaken in an area receiving polluted effluents. Enteroviruses were detected in 21 out of 38 samples (55%). Viruses were found as far as 5 km from the shoreline and at a depth of 82 m. Multiple correlations between enteroviruses and bacteria, detected in the same samples, were computed. No correlation could be demonstrated between virus numbers and any other parameter in sediment samples collected south of Barcelona. This lack of correlation is probably due to the different decay rates shown by bacteria and viruses. In contrast, the cases where pollution resulted from a more recent deposition, as in sediment samples collected north of Barcelona, enterovirus levels were correlated with fecal streptococci levels. (Author's abstract)
W89-05022

PETROLEUM HYDROCARBONS IN THE MARINE BIVALVE VENUS VERRUCOSA: ACCUMULATION AND CELLULAR RESPONSES,
Malta Univ., Msida. Dept. of Mathematics and Science.
For primary bibliographic entry see Field 5C.
W89-05035

ENVIRONMENTAL AQUATIC PHOTOCHEMISTRY OF CHLORINATED AROMATIC POLLUTANTS (CAPS),
Manitoba Univ., Winnipeg. Pesticide Research Lab.
G. G. Choudhry, G. R. B. Webster, and O. Hutzinger.
Toxicological and Environmental Chemistry TXECBP, Vol. 17, No. 4, p 267-286, 1988. 2 tab, 42 ref.

Descriptors: *Chlorinated hydrocarbons, *Humic acids, *Photochemistry, *Fate of pollutants, Benzenes, Toluenes, Phenols, Diphenyl ethers, Dibenzo-p-dioxins.

A literature review is presented on the environmentally significant photoreactions of several chlorinated aromatic pollutants (CAPs), namely, polychlorobenzenes (PCBzs) as well as CAPs derived from them, including alpha-substituted p-chlorotoluenes, polychlorophenols, polychlorodiphenyl ethers and polychlorodibenzo-p-dioxins at > 290 nm. In the context of the photochemistry of PCBzs, the discussions include photoreductive dechlorination, photoisomerization, photoformation of polychlorobiphenyls and many other photoprocesses. Newly developed photoincorporating reactions of PCBzs with some humic monomers are also described. (Author's abstract)
W89-05047

CHLOROPHENOLS IN THE SAVA RIVER BEFORE, IN AND AFTER THE ZAGREB CITY AREA: IMPACT ON THE PURITY OF THE CITY GROUND AND DRINKING WATERS,
Yugoslav Academy of Sciences and Arts, Zagreb. Inst. for Medical Research and Occupational Health.
S. Fingler, and V. Drevenkar.
Toxicological and Environmental Chemistry TXECBP, Vol. 17, No. 4, p 319-328, 1988. 2 fig, 3 tab, 20 ref.

Descriptors: *Sava River, *Chlorinated hydrocarbons, *Path of pollutants, *Phenols, *Groundwater pollution, *Yugoslavia, *Drinking water, *Industrial wastewater, Wells, Zagreb.

The presence of 4-chloro-, 2,4-dichloro-, 2,4,5- and 2,4,6-trichloro-, 2,3,4,6-tetrachloro- and pentachlorophenol was investigated in samples of the Sava River collected upstream of the Zagreb city area, in the area downstream of it and in ground and drinking water samples from the city area. In almost all of the river water samples higher chlorinated phenols were detected, with pentachlorophenol present in highest concentrations, but not exceeding 160 ng/L. The chlorophenol levels in groundwater samples from wells 0.2-0.4 km from the river bed were comparable to those in the river. Their presence in the river water did not appear to have an effect on the purity of groundwater from the wells about 2 km away from the river. The occurrence of chlorophenols in the city drinking water seems to be mainly a consequence of occasional contamination of the groundwater network by uncontrolled underground industrial waste discharge. (Author's abstract)
W89-05049

REDUCTION OF SELENATE BY FULVIC ACIDS IN SOILS OF A HIGH GASTRIC CANCER RISK AREA IN SRI LANKA,
Institute of Fundamental Studies, Kandy (Sri Lanka).
S. V. R. Weerasooriya, S. B. Bulumulla, S. A. Tilekaratne Bandara, and M. U. Jayasekara.
Toxicological and Environmental Chemistry TXECBP, Vol. 17, No. 4, p 329-336, 1988. 4 fig, 16 ref.

Descriptors: *Path of pollutants, *Selenium, *Fulvic acids, Soil chemistry, *Carcinogens, *Sri Lanka, Nitrosamines, Hydrogen ion concentration.

In order to elucidate the probable etiological factors for the high incidence of gastric cancer in the northern and western regions of Sri Lanka, the interaction between selenate and fulvic acids was investigated under chemically controlled conditions. The reduction ability of selenate by fulvic acids was enhanced in acidic conditions. Fulvic acids may play an important role in the nitrosation process. Selenate ion can block the formation of N-nitrosamines via oxidation of the functional groups of the fulvic acids to yield harmless products, e.g. CO2. (Sand-PTT)
W89-05050

DISCRIMINATION AMONG ONE-DIMENSIONAL MODELS OF SOLUTE TRANSPORT IN POROUS MEDIA: IMPLICATIONS FOR SAMPLING DESIGN,
Geological Survey, Reston, VA.
D. S. Knopman, and C. I. Voss.
Water Resources Research WRERAO, Vol. 24, No. 11, p 1859-1876, November 1988. 11 fig, 9 tab, 28 ref.

Descriptors: *Sampling, *Network design, *Data acquisition, *Path of pollutants, *Model studies, *Porous media, *Solute transport, Aquifers, Mathematical models, Nonlinear regression.

A methodology developed for discrimination among models of transient transport in porous media utilizes nonlinear regression on observations of solute concentration. Discrimination requires comparisons of model predictions to observations, systematic error in residuals, stability in parameter estimates from regression on different observation sets, and other measures of model fit among hypothesized models of transport. The set of observations of solute concentration to which models are fitted strongly influences the assessment of these discrimination criteria. The most desirable observation set for discrimination amplifies the weaknesses of these models that appear to describe existing conditions but are in fact unsuitable for prediction. The inadequacies of various observation sets are illustrated in four examples of discrimination between one-dimensional models of solute transport. The purpose is to understand the physical, deterministic basis of sampling design for model discrimination. In addition to physical attributes such as transport processes, boundary conditions, and flow geometry, the assumed distribution of random error in the regression model is also treated as a model attribute to be tested by the designed experiment. A common problem in field studies occurs when the set of available observations does not include sufficient information with which to discriminate among hypothesized models, hence supporting the need to design a second round of sampling specifically for discrimination. A proposed objective function in the sampling design problem favors design points at locations and times when two hypothesized transport models display the greatest differences in predicted concentration. Two hypothetical examples demonstrate the effectiveness of the objective function and the application of the discrimination criteria. (Author's abstract)
W89-05056

EFFECTIVE PERMEABILITY AND DISPERSION IN LOCALLY HETEROGENEOUS AQUIFERS,
Technische Hogeschool Twente, Enschede (Netherlands).
For primary bibliographic entry see Field 2F.
W89-05061

PHYSICAL, CHEMICAL, AND BIOLOGICAL CHARACTERISTICS OF THE TURKEY LAKES WATERSHED, CENTRAL ONTARIO, CANADA,
Canada Centre for Inland Waters, Burlington (Ontario).
D. S. Jeffries, J. R. M. Kelso, and I. K. Morrison.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 45, Suppl. 1, p 3-13, 1988. 3 fig, 8 tab, 46 ref.

Descriptors: *Water pollution sources, *Acid rain effects, *Canada, *Acid rain, *Air pollution effects, *Lakes, Watersheds, Physical properties, Chemical properties, Biological properties, Aquatic environments, Precipitation, Dissolved oxygen, Ions, Seasonal variation, Fish populations, Benthic environment, Ontario.

The Turkey Lakes Watershed (TLW) in Central Ontario was selected for intensive research into the effects of long-range transport of air pollutants (primarily acidic deposition) on a site on the Canadian Shield having both vulnerable terrain and an undisturbed Great Lakes forest type. The TLW contains a chain of four lakes (five distinct lake basins) that range from 5.8 to 52.0 hectares in area and 2.2 to 12.2 meters in mean depth. The lakes are dimictic and, except for the deepest lake, experience dissolved oxygen depletion in undisturbed bottom waters. There is a gradient in the major ion composition of lakes within the TLW, the most dilute waters occurring at high elevations. Calcium levels increase down the chain. Sulfate is the dominant lake water ion in the headwater lake, while alkalinity dominates in the lowest lake. Phosphorus is the limiting nutrient in these lakes; NO3-N levels are relatively high because the terrestrial basin exhibits low utilization of this nitrogen species. Seasonal and episodic variations in surface water composition can be large. The headwater lake contains no fish; however fish communities in the lower three lakes are composed of 8-11 species. The distribution of benthic organisms is primarily a function of lake depth and presence or absence of fish rather than variations in water chemistry. Zooplankton species composition is similar across all lakes, and cyanophytes are the dominant algae throughout. The forest is an uneven-aged, mature to over-mature old-growth tolerant hardwood stand. The principal tree species is sugar maple with lesser amounts of other hardwoods and various conifers. Production is typical of forest at this northerly latitude. Foliar bioelement concentrations are generally similar to those observed at Hubbard Brook, New Hampshire. (See W89-05083 thru W89-05106) (Author's abstract)
W89-05082

DETAILED ANALYSIS OF SULPHATE AND NITRATE ATMOSPHERIC DEPOSITION ESTIMATES AT THE TURKEY LAKES WATERSHED,

Atmospheric Environment Service, Downsview (Ontario).
A. Sirois, and R. J. Vet.

Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 45, Suppl. 1, p 14-25, 1988. 6 fig, 3 tab, 11 ref.

Descriptors: *Water pollution sources, *Acid rain, *Air pollution effects, *Lakes, *Canada, Deposition, Watersheds, Ontario, Precipitation, Sulfates, Nitrates, Seasonal variation, Statistical analysis.

Daily concentrations of sulfates and nitrates in air and precipitation were measured at the Turkey Lakes Watershed in central Ontario from September 1980 until December 1984. The measurement data were used to estimate wet, dry, and total deposition of sulfates and nitrates to the watershed. Over the four years, the annual values of total (wet plus dry) deposition ranged from 34 to 38 (plus/minus 15%) mmol/sq m/yr for SO4(--) and from 38 to 47 (plus/minus 30%) mmol/sq m/yr for NO3(-). On a molar basis, the deposition of NO3(-) exceeded the deposition of total SO4(--) by 19%. However, when converted to equivalents, total SO4(--) exceeded total NO3(-) by 68%. Dry deposition represented approximately 15 and 25% of the total deposition of SO4(--) and NO3(-), respectively, to the watershed. Wet and dry deposition of sulfate and nitrate was found to be highly episodic, with the top 20% of daily events delivering 60-70% of the total sulfur and nitrogen deposition to the watershed. Statistically significant seasonal cycles were found in the concentration and deposition values of most of the sulphur and nitrogen species measured at the watershed. (See W89-05082 and W89-05084 thru W89-05101) (Author's abstract)
W89-05083

COMPARISON OF BULK, WET-ONLY, AND WET-PLUS-DRY DEPOSITION MEASUREMENTS AT THE TURKEY LAKES WATERSHED,

Atmospheric Environment Service, Downsview (Ontario).
R. J. Vet, A. Sirois, D. S. Jeffries, R. G. Semkin, and N. W. Foster.

Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 45, Suppl. 1, p 26-37, 1988. 4 fig, 1 tab, 13 ref.

Descriptors: *Water pollution sources, *Lakes, *Canada, *Acid rain, *Air pollution effects, *Deposition, Watersheds, Comparision studies, Statistical methods, Sulfates, Nitrates, Data interpretation, Variability, Lake basins, Ontario.

Four different types of atmospheric deposition measurements were made at the Turkey Lakes Watershed in central Ontario from 1981 to 1984. They included weekly and variable period bulk deposition measurements. The resulting annual and seasonal deposition estimates from the four methods were compared for numerical and statistical differences. Several results unexpected from the theory of the measurement methods appeared in the comparison: (1) one of the bulk deposition measurements produced lower deposition of acid-related ions than the two wet-only measurements and (2) the monthly wet-only measurements produced higher deposition of sulfate than the two bulk deposition data sets (by 6 and 19%). Several results were consistent with the theory of the measurements: (1) the daily wet-only measurements produced deposition values lower than the weekly bulk deposition measurements and (2) the wet-plus-dry deposition measurements produced higher estimates of sulfate and nitrate deposition than the two bulk data sets (15-35% higher). Laboratory biases appeared to be partially responsible for some of the differences found in the comparison. (See W89-05082 thru W89-05083 and W89-05085 thru W89-05101) (Author's abstract)
W89-05084

CHEMISTRY OF ATMOSPHERIC DEPOSITION, THE SNOWPACK, AND SNOWMELT IN THE TURKEY LAKES WATERSHED,

National Water Research Inst., Burlington (Ontario). Rivers Research Branch.
R. G. Semkin, and D. S. Jeffries.

Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 45, Suppl. 1, p 38-46, 1988. 7 fig, 7 tab, 21 ref.

Descriptors: *Samplers, *Water pollution sources, *Canada, *Acid rain, *Air pollution effects, *Watersheds, *Snow, Comparison studies, Deposition, Snowpack, Snowmelt, Nitrates, Sulfates, Ions, Chemical analysis, Lake basins, Ontario.

Bulk and wet-only deposition and the snowpack were monitored at the Turkey Lakes Watershed in northern Ontario over the winter and spring of 1986. Based on a comparison with snowpack and cumulative snowmelt, the bulk sampler overcollected major ions by factors ranging from 6 to 22%. Nitrate appeared to be preferentially collected by the bulk sampler relative to SO4(--) during snow events. Dry deposition was estimated to be 12 and 5% of total deposition for SO4(--) and NO3(-), respectively. Ion budgets for cumulative bulk deposition and snowmelt supported the hypothesis that ion losses from the snowpack are insignificant during a winter having no melt episodes. Snowmelt was characterized by chemical fractionation of major ions; SO4(--) and H(+) in initial meltwaters were ten times more concentrated than the premelt snowpack. Preferential elution of ions in the snowmelt followed the sequence: SO4(--) > NO3(-) > H(+) > Cl(-). Snowmelt chemistry was used to predict changes in lake chemistry: H(+), NO3(-), and NH4(+) levels should increase in lake waters; Ca(++) decreases through dilution by snowmelt; SO4(--) concentrations remain fairly constant. (See W89-05082 thru W89-05084 and W89-05086 thru W89-05101) (Author's abstract)
W89-05085

ION MASS BUDGETS FOR LAKES IN THE TURKEY LAKES WATERSHED, JUNE 1981-MAY 1983,

National Water Research Inst., Burlington (Ontario).
D. S. Jeffries, R. G. Semkin, R. Neureuther, and M. Seymour.

Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 45, Suppl. 1, p 47-58, 1988. 3 fig, 9 tab, 33 ref.

Descriptors: *Water pollution sources, *Seepage, *Canada, *Acid rain, *Watersheds, *Air pollution effects, *Hydrologic budget, *Ion transport, Deposition, Acidification, Groundwater runoff, Path of pollutants, Lake basins, Chemistry, Ion exchange, Ontario, Sulfates, Nitrates, Ammonia, Path of pollutants.

Ion mass budgets were determined for two water years (June-May 1981-1983) for Batchawana Lake South, Wishart Lake, Little Turkey Lake and Turkey Lake in Ontario. Water budgets balance within measurement error except for Little Turkey Lake (output surplus for both water years) and Batchawana Lake South (output surplus for 1982-1983). Groundwater seepage is hypothesized to explain these water budget imbalances. The chemical budgets show that H(+), NH4(+), and NO3(-) are retained by the lakes to varying degrees. The major input pathway for H(+) and NH4(+) is via direct atmospheric deposition, while relatively weaker terrestrial retention of NO3(-) causes basin runoff to be the major input pathway for this parameter. All three species are playing an acidifying role on the Turkey Lakes Watershed. Chemical budgets for Mg(++), Na(+), K(+), SO4(--), and Cl(-) are generally balanced for all lakes relative to the water budgets. In contrast, Ca(++) and acid-neutralizing capacity exhibit excess output over measured plus estimated inputs. Probable unmeasured inputs of these two parameters include groundwater seepage and Ca(++) exchange with the sediments. In-lake generation of acid-neutralizing capacity by SO4(--) reduction is of minor importance. (See W89-05082 thru W89-05085 and W89-05087 thru W89-05101) (Author's abstract)
W89-05086

ACID PRECIPITATION AND GROUNDWATER CHEMISTRY AT THE TURKEY LAKES WATERSHED,

National Hydrology Research Inst., Saskatoon (Saskatchewan).
D. Craig, and L. M. Johnston.

Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 45, Suppl. 1, p 59-65, 1988. 8 fig, 1 tab, 21 ref.

Descriptors: *Water pollution sources, *Surface-groundwater relations, *Canada, *Acid rain, *Lakes, *Path of pollutants, Chemical properties, Groundwater, Weathering, Carbonates, Groundwater runoff, Hydrologic budget, Flow rates, Mineralogy, Stratigraphy, Alkaline water, Ontario.

To determine correctly the response of a basin to various acid-loading events, the groundwater hydrology must be considered as a function of the basin stratigraphy and mineralogy. Groundwaters in the Turkey Lakes Watershed in Ontario are well buffered and in general provide a reservoir of alkalinity for surface waters in the basin. The groundwater chemistry is dominated by the weathering of carbonates present in the tills. Groundwater can follow a variety of pathways through the subsurface. These pathways can have very different flow rates and groundwater chemistry. As a result of this the influence of groundwater on surface water is highly site-specific. (See W89-05082 thru W89-05086 and W89-05088 thru W89-05101) (Author's abstract)
W89-05087

ALUMINUM CONTAMINATION OF GROUNDWATER: SPRING MELT IN CHALK RIVER AND TURKEY LAKES WATERSHEDS--PRELIMINARY RESULTS,

National Hydrology Research Inst., Saskatoon (Saskatchwan). Ground Water Div.
H. Chew, L. M. Johnston, D. Craig, and K. Inch.

Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 45, Suppl. 1, p 66-71, 1988. 5 fig, 18 ref.

Descriptors: *Acid rain effects, *Path of pollutants, *Groundwater pollution, *Aluminum, *Canada, *Watersheds, *Seasonal variation, Comparison studies, Hydrogen ion concentration, Watershed models, Acid rain, Air pollution effects, Carbonates, Chemical properties, Groundwater runoff, Data interpretation, Surface-groundwater relations, Snowmelt, Ontario.

Two watersheds with seasonal pH depressions in the groundwater exhibit high aluminum concentrations associated with these acidification events. The watersheds receive similar atmospheric loadings of H(+) and SO4(--) but are covered by different surficial deposits. The aluminum was measured in four fractions by varying the pH and time conditions during analysis. The resulting classes calculated from these fractions are Class a, containing fast-reacting monomeric aluminum, predominantly inorganic Al(+3) and hydroxy compounds; Class b, containing fast-reacting complex aluminum species, mainly inorganic F(-) complexes and simple organic complexes; Class c, containing slow-reacting amorphous and some polymeric aluminum species; and a class containing a residue of unknown aluminum species adding to the total acid-extractable aluminum. There are significant differences in the distribution of the various aluminum species between the two watersheds, both with depth and in the predominant class identified. The generally higher values measured at one watershed are consistent with the lower carbonate content of the overburden. In both locations it appears that the controlling factor is the pH of the groundwater, with all but Class c species increasing with decreasing pH. The difference between the distributions of aluminum species in groundwater and surface water is under investigation to determine the influence of groundwater-borne aluminum on the surface water into which it flows. (See W89-05082 thru W89-05087 and W89-05089 thru W89-05101)

W89-05088

MODELLING STREAM CHEMISTRY FOR THE TURKEY LAKES WATERSHED: COMPARISON WITH 1981-84 DATA,
Canada Centre for Inland Waters, Burlington (Ontario).
D. C. L. Lam, A. G. Bobba, D. S. Jeffries, and D. Craig.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 45, Suppl. 1, p 72-80, 1988. 5 fig, 2 tab, 20 ref.

Descriptors: *Acid rain effects, *Model studies, *Canada, *Surface-groundwater relations, *Watershed models, *Streams, *Path of pollutants, Calcium, Magnesium, Ion transport, Biological properties, Lake basins, Groundwater, Hydrogen ion concentration, Alkaline water, Statistical methods, Data interpretation, Ontario, Comparison studies.

Simulation results obtained from interfacing a hydrological model with a hydrogeochemical model were used to explain the increase of Ca(++) + Mg(++), alkalinity, and pH in a progressively buffered stream system in the Turkey Lakes Watershed, Ontario. Results from the model, which were calibrated with observed data for 1981, were confirmed with those from 1982, 1983, and 1984. The results further supported the hypothesis that the increases of the groundwater input of Ca into the lower streams contributed to the increase of alkalinity and pH in the downstream lakes which appeared to have caused a corresponding increase in the biological primary productivity in these lakes. (See W89-05082 thru W89-05088 and W89-05090 thru W89-05101)(Author's abstract)
W89-05089

APPLICATION OF A HYDROLOGICAL MODEL TO THE ACIDIFIED TURKEY LAKES WATERSHED,
National Water Research Inst., Burlington (Ontario). Rivers Research Branch.
A. G. Bobba, and D. C. L. Lam.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 45, Suppl. 1, p 81-87, 1988. 6 fig, 2 tab, 17 ref.

Descriptors: *Path of pollutants, *Acid rain effects, *Statistical methods, *Model studies, *Canada, *Hydrologic models, *Watershed models, *Sulfates, Variability, Snowpack, Variation coefficient, Geology, Geomorphology, Chemical properties, Groundwater movement, Streams, Ontario, Comparison studies.

A hydrological model applied to the Turkey Lakes Watershed at different locations produced results which agreed closely with observed stream flow, groundwater flow, snowpack, and snowpack chemistry. The model results are consistent with many of the episodic events that have occurred in the watershed. The snowpack sulfate concentration was simulated with a simple sulfate model linked to the hydrological model. The different calibrated hydrological coefficients were found to vary with the geology and geomorphology at several locations in the watershed. The general applicability of these coefficients was confirmed by comparing model results with a new set of data from subsequent years. (See W89-05082 thru W89-05089 and W89-05091 thru W89-05101) (Author's abstract)
W89-05090

WATER AND CHEMICAL BUDGETS FOR TERRESTRIAL BASINS AT THE TURKEY LAKES WATERSHED,
Great Lakes Forestry Research Centre, Sault Sainte Marie (Ontario).
For primary bibliographic entry see Field 2A.
W89-05091

ACID DEPOSITION AND NUTRIENT LEACHING FROM DECIDUOUS VEGETATION AND PODZOLIC SOILS AT THE TURKEY LAKES WATERSHED,
Great Lakes Forestry Research Centre, Sault Sainte Marie (Ontario).
N. W. Foster, and J. A. Nicolson.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 45, Suppl. 1, p 96-100, 1988. 3 tab, 22 ref.

Descriptors: *Acid rain effects, *Canada, *Leaching, *Vegetation, *Soils, *Forest watersheds, Podzols, Deciduous forests, Nutrients, Mineralization, Percolation, Air pollution effects, Runoff, Ion transport, Ontario.

Mean annual ion concentrations and ion fluxes in precipitation induced by contact with a maple-birch forest and soil were determined for 1981-1985 at the Turkey Lakes Watershed. Neutralization of atmospherically deposited H(+) was effected by the canopy and mineral soil. Sulfate was an important counter-ion for K(+) leached from the vegetation. Acid deposition had a minor impact on the quality of stemflow and forest floor percolate, which were enriched in K(+) and Ca(++) mobilized in association with organic anions. Calcium and Mg(++) were leached from the mineral soil in association with SO4(-) and NO3(-). Sulfate was derived largely from acid deposition, and NO3(-) from both precipitation and nitrification of native soil. (See W89-05082 thru W89-05091 and W89-05091 thru W89-05101) (Authors abstract)
W89-05092

STUDY OF METAL ACCUMULATION TRENDS IN SEDIMENT CORES FROM THE TURKEY LAKES (ALGOMA, ONTARIO),
Laurentian Univ., Sudbury (Ontario). Dept. of Biology.
J. R. Morris, and W. Kwain.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 45, Suppl. 1, p 145-154, 1988. 5 fig, 5 tab, 30 ref.

Descriptors: *Air pollution effects, *Lake sediments, *Metals, *Canada, *Path of pollutants, Variability, Vertical distribution, Temporal distribution, Aluminum, Manganese, Lead, Zinc, Copper, Nickel, Dry matter, Concentration time, Oxidation, Sedimentation rates, Acid rain, Data interpretation, Watersheds, Ontario.

Temporal (vertical) and spatial trends in sediment accumulations of nonresidual aluminum, manganese, lead, zinc, copper, and nickel were investigated in 18 core samples collected from four of the Turkey Lakes in 1980-1981. Accumulation rates of nonresidual Al differed among sampling sites, both within and among lakes, but was assumed to have been temporally constant at each location. Concentrations of dry matter and all other metals were expressed as mass per unit mass of Al. Cumulative Al was used as an index of time. Since Mn enrichments near the sediment surface may reflect an oxidation zone, they were not interpreted as increased Mn inputs. Other metal enrichments were considered anthropogenic. Little Pb occurred at the bottom of sediment cores, but Pb accumulation rates increased greatly toward the sediment surface. Major Pb enrichments were assumed to have begun at 1940. Zn accumulation rates had also progressively increased through most of the previous four decades. During the same period, there was a modest rise in Cu and Ni accumulation rates. Metal accumulation rates differed considerably among lakes, and among sites within lakes, but these differences primarily reflected variations in dry matter sedimentation rates. (See W89-05082 thru W89-05097 and W89-05099 thru W89-05101) (Author's abstract)
W89-05098

SEDIMENT PH IN PROFUNDAL CORE SAMPLES FROM THE TURKEY LAKES (ALGOMA, ONTARIO),
Laurentian Univ., Sudbury (Ontario). Dept. of Biology.
J. R. Morris, and W. Kwain.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 45, Suppl. 1, p 155-158, 1988. 2 fig, 18 ref.

Descriptors: *Acid rain effects, *Canada, *Air pollution effects, *Lake sediments, *Hydrogen ion concentration, Cores, Watersheds, Deposition, Comparison studies, Path of pollutants, Ontario.

Vertical pH profiles were recorded in sediment cores from four of the Turkey Lakes in the Algoma region of northern Ontario. In the three upper lakes of the chain, median down-core pH, which should be correlated with historic lake water pH, was below the median down-core pH for other lakes in northeastern Ontario. The Turkey Lakes had probably been relatively acidic, therefore, since pre-industrial times. Down-core pH tended to be lower in upstream lakes. While a pH minimum was typically observed at the sediment-water interface, the surficial sediments were not acidified relative to down-core sediments. (See W89-05082 thru W89-05098 and W89-05100 thru W89-05101) (Author's abstract)
W89-05099

EFFECT OF ACID PRECIPITATION ON MICROBIAL DECOMPOSITION PROCESSES IN SEDIMENT FROM STREAMS IN THE TURKEY LAKES WATERSHED,
Guelph Univ. (Ontario). Dept. of Environmental Biology.
For primary bibliographic entry see Field 5C.
W89-05100

LOADINGS OF ORGANOCHLORINE CONTAMINANTS AND TRACE ELEMENTS TO TWO ONTARIO LAKE SYSTEMS AND THEIR CONCENTRATIONS IN FISH,
Department of Fisheries and Oceans, Burlington (Ontario).
M. G. Johnson, J. R. M. Kelso, and S. E. George.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 45, Suppl. 1, p 170-178, 1988. 2 fig, 5 tab, 33 ref.

Descriptors: *Path of pollutants, *Fate of pollutants, *Canada, *Chlorinated hydrocarbons, *Trace elements, *Lakes, *Acid rain, Chemical precipitation, Fish conservation, Hydrologic systems, Regression analysis, Hardness, Variability, Runoff, Ontario, Copper, Nickel, Zinc.

Direct precipitation contributed >90% of organochlorine loadings to Emmett and Bartley Lakes and three Turkey Lakes. The organochlorines with highest lake loadings were PCBs, alpha-BHC, gamma-BHC, methoxychlor, HCB, and dieldrin with means of 31.6, 26.9, 7.2, 1.4, 1.0, and 1.0 micrograms/sq m/year, respectively. Heptachlor epoxide, alpha- and gamma-chlordane, and alpha- and beta-endosulfan, endrin, and total DDT had mean loadings of 0.1-0.9 micrograms/sq m/year, mostly from direct precipitation. Heptachlor, aldrin, and mirex were not detected in precipitation, runoff, or fish samples. gamma-BHC, methoxychlor, alpha- and beta-endosulfan, and endrin were not detected in any fish of five species from the five lakes but they had significant lake loadings. In multiple regression analysis, 42-68% of the variability in residues of organochlorines in fish was accounted for by lake loading and octanol:water partition coefficient (to quantify lipophilicity). Relatively high concentrations of total DDT occurred in fish because of high lipophilicity, high concentrations of alpha-BHC occurred because of high loading, and high concentrations of PCB were attributable to both factors. Trace element loadings in runoff were generally higher than in precipitation to the softwater lakes and lower in the hardwater system. Pb concentrations in fish were proportional to loadings, but Cu and Ni residues in fish were less variable than their loadings, and Zn loadings and residues were fairly uniform. Hg showed highest biomagnification (residue in relation to loading), and the larger piscivorous fish had the highest residues. (See W89-05082 thru W89-05100) (Author's abstract)
W89-05101

MULTIVARIATE ANALYSIS OF CORRELATIONS BETWEEN ENVIRONMENTAL PARAMETERS AND CADMIUM CONCENTRATIONS IN HYALELLA AZTECA (CRUSTACEA:

AMPHIPODA) FROM CENTRAL ONTARIO LAKES,
Guelph Univ. (Ontario). Dept. of Zoology.
M. Stephenson, and G. L. Mackie.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 45, No. 10, p 1705-1710, October 1988. 2 fig, 5 tab, 22 ref. NSERC Grant G0918.

Descriptors: *Path of pollutants, *Lake morphometry, *Cadmium, *Amphipods, Multivariate analysis, Principal component analysis, Crustacea, Water properties, Littoral zone, Calcium, Correlation analysis, Ontario, Canada, Organic carbon, Statistical analysis.

Cadmium concentrations in Hyalella azteca collected from 69 central Ontario lakes ranged from 0.13 to 56.6 micrograms/gram dry mass. Principal components analysis followed by multiple linear regression found three principal components, interpreted as water hardness, total cadmium, and dissolved organic carbon concentrations, to be significantly correlated with cadmium concentrations in H. azteca. Cadmium concentrations in H. azteca were independent of cadmium concentrations in littoral sediments. It is suggested that cadmium ions compete with calcium ions for uptake sites on the gill surfaces of H. azteca. High concentrations of dissolved organic carbon may complex free cadmium ions and reduce their concentration in solution, leading to lower cadmium concentrations in H. azteca. (Author's abstract)
W89-05103

ACCUMULATION OF MERCURY BY PLANKTON AND BENTHIC INVERTEBRATES IN RIVERINE LAKES OF NORTHERN MANITOBA (CANADA): IMPORTANCE OF REGIONALLY AND SEASONALLY VARYING ENVIRONMENTAL FACTORS,
National Hydrology Research Inst., Saskatoon (Saskatchewan).
T. A. Jackson.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 45, No. 10, p 1744-1757, October 1988. 11 fig, 7 tab, 28 ref.

Descriptors: *Bioaccumulation, *Benthic environment, *Path of pollutants, *Mercury, Seasonal variation, Regional analysis, Lakes, Water currents, Plankton, Methylation, Suspended sediments, Aeration, Manitoba, Canada.

Mercury (Hg) concentrations in plankton and benthic invertebrates from riverine lakes of northern Manitoba were generally found to be unrelated, or inversely related, to inorganic and methyl mercury levels and Hg methylation rates in their habitats but were strongly dependent on environmental factors. The relationships suggest that the uptake of Hg by these organisms was controlled largely by suspended and sedimentary Hg-binding substances such as FeOOH, MnOOH, organic matter, sulfides, and clay. The sole exception was midsummer phytoplankton, whose Hg content was a function of Hg levels in local sediments, probably because interference by suspended detritus was minimal; during the spring flood, such interference had a predominant effect. Aeration of lake water by fluvial currents probably enhances the availability of Hg to plankton by promoting decomposition of organic matter and sulfides but decreases the availability of Hg to some benthic animals by causing MnOOH precipitation. FeOOH apparently limits Hg uptake by chironomid larvae but MnOOH limits Hg uptake by oligochaetes, nematodes, and pelecypods, suggesting preferential uptake of certain forms of Hg by particular biological and mineral species. Decreases in temperature may also retard Hg uptake by benthos. Biodilution has no significant effect on Hg accumulation by benthos or plankton. (Author's abstract)
W89-05104

INTERNAL NITROGEN AND PHOSPHORUS LOADS IN LAKE ROTORUA, NEW ZEALAND,
Ministry of Works and Development, Hamilton (New Zealand). Water Quality Centre.
For primary bibliographic entry see Field 5C.
W89-05177

VI. MAN-MADE LAKES: SOME PHYSICO-CHEMICAL ASPECTS OF LAKE SAINT-JEAN, QUEBEC, CANADA,
Quebec Univ., Sainte-Foy.
For primary bibliographic entry see Field 2H.
W89-05183

HEAVY METAL DISTRIBUTION AND WATER QUALITY ASPECTS OF A NEWLY IMPOUNDED GOLD MINING RESERVOIR,
Nevada Univ., Las Vegas. Environmental Research Center.
R. Axler, J. E. Reuter, D. Slotton, and C. Goldman.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IVTLAP, Vol. 23, No. 2, p 968-975, August 1988. 1 fig, 3 tab, 21 ref.

Descriptors: *Dam effects, *Water pollution sources, *Gold mines, *Reservoirs, *Heavy metals, *Davis Creek Reservoir, California, Chromium, Mercury, Nickel, Zinc, Sediment, Zooplankton, Cache Creek, Leachates, Mine drainage.

Davis Creek Reservoir was created in November 1984 to serve as a water supply for mining operations at the McLaughlin Gold Mine in the historic Knoxville mining district in California. Davis Creek is a hardwater, seasonal tributary to Cache Creek which serves as a major source of water for farming, and domestic uses in addition to its wildlife and recreational benefits. Monitoring data collected from 1981 to 1984 showed that Davis Creek was a regionally typical, hardwater, Coast Range stream characterized by fluctuations in flow, and poor water quality, often unfit for both consumption and irrigation. Drainage from the abandoned Reid Mercury Mine contributes high levels of Fe, Mn, Hg, and probably sulfate. The Reservoir is hydrologically separate from the tailings pond, mine pit, and waste rock disposal sites of the McLaughlin Gold Mine. However, it receives inputs of heavy metals from native basin soils, leachate from upstream old tailings piles, and a continuous trickle from an adit in the abandoned Reid Mercury Mine. Most of the heavy metals monitored in water, sediments, and biological tissues have been either undetectable or far enough below available criteria to be of no significant concern as yet. However, concentrations of Cr, Hg, Ni, and Zn were relatively high. The reduction in the seasonality of downstream flow is the most important impact of the dam; the reservoir requires prudent management to avoid problems due to discharges of anoxic water. (Davis-PTT)
W89-05184

NUTRIENT LOAD AND PROVISIONAL VALUATION IN AN ARTIFICIAL RESERVOIR,
Centro di Studio sulla Biologia Cellulare e Molecolare delle Piante, Milan (Italy). Dipt. di Biologia.
M. Cotta-Ramusino, and G. Crosa.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IVTLAP, Vol. 23, No. 2, p 1011-1013, August 1988. 3 fig, 1 tab, 4 ref.

Descriptors: *Liminology, *Lake morphometry, *Water pollution sources, *Reservoirs, *Hydrological regime, *Nutrients, Domestic wastes, Municipal wastewater, Seasonal variation, Dirillo, Italy, Wastewater pollution, Phosphorus, Nitrogen.

The Dirillo, the southernmost artificial reservoir in Italy, was created by damming its only feeder, a torrential stream whose spates and trickles coincide with the trend of rainfall and which carries into the lake the sewage effluent of some 12,000 people. There are no industrial discharges, and other activities such as agriculture and pasture usage are negligible in the drainage area. On the basis of the hydrological parameters, two characteristic periods of the reservoir's annual cycle have been identified: the dynamics of the changes in the amounts of phosphorus and of nitrogen and their concentrations in the reservoir during the high water period (winter) and the low water period (summer). The reservoir's prevalent nutritional regime is characterized by the amounts brought in during the winter flooding. The peculiar hydrology of reservoirs of this type leads to a lowering of the concentration of nutrients. (Davis-PTT)
W89-05188

SEDIMENTS IN THE PERIODICALLY EXPOSED MARGINAL ZONE OF A HYPERTROPHIC RESERVOIR: THE INFLUENCE OF EXPOSURE IN PHOSPHATE EXCHANGE CHARACTERISTICS,
National Inst. for Water Research, Pretoria (South Africa).
For primary bibliographic entry see Field 2H.
W89-05189

PRIMARY PRODUCTION IN A SMALL AGRICULTURAL STREAM,
Iowa State Univ., Ames. Dept. of Animal Ecology.
For primary bibliographic entry see Field 5C.
W89-05205

YEARLY FLUX OF VIRUS-LIKE PARTICLES AND HUMIC ACID IN RIVER SEDIMENT,
Davidson Coll., NC. Dept. of Biology.
For primary bibliographic entry see Field 5A.
W89-05210

DERIVED FREQUENCY DISTRIBUTION FOR STORM RUNOFF POLLUTION,
Old Dominion Univ., Norfolk, VA. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W89-05225

CONTROL OF VOC EMISSIONS FROM WASTE MANAGEMENT FACILITIES,
New York State Dept. of Environmental Conservation, Albany.
For primary bibliographic entry see Field 5E.
W89-05229

LEAKAGE RATES THROUGH FLAWS IN MEMBRANE LINERS,
Texas A and M Univ., College Station. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5E.
W89-05230

ASSESSMENT OF PROBABILITY DISTRIBUTION OF DISSOLVED OXYGEN DEFICIT,
Wyoming Univ., Laramie. Water Resources Research Inst.
Y.-K. Tung, and W. E. Hathhorn.
Journal of Environmental Engineering JOEDDU, Vol. 114, No. 6, p 1421-1435, December 1988. 1 fig, 6 tab, 24 ref.

Descriptors: *Model studies, *Probability distribution, *Dissolved oxygen, *Oxygen deficit, *Streams, Water quality, Mathematical analysis, Hydrologic models, Model testing, Water quality criteria.

Water quality modeling and prediction in a stream environment is complicated by the occurrence of a number of random processes. Due to the complexity of water quality models, the analytical derivation of the exact probability distribution of the dissolved oxygen (DO) deficit is difficult. This paper proposes an approximate but practical method by using first-order analysis of uncertainty in estimating the statistical moments of the DO deficit. The statistical moments estimated were then used in an appropriate probability distribution for the DO deficit concentration. Practical issues involved are : (1) Finding the appropriate probability distribution for the DO deficit concentration and (2) finding if this appropriate distribution function is sensitive to the distribution of water quality parameters. This paper examines a number of commonly used probability distributions for their appropriateness in describing the random characteristics of the DO deficit concentration under various conditions. Of the distributions considered in the

investigation, lognormal distribution proved to be the best model. (Author's abstract)
W89-05231

ACCUMULATION AND EXCRETION OF FIVE HEAVY METALS BY THE SALTMARSH CORDGRASS SPARTINA ALTERNIFLORA,
Hackensack Meadowlands Development Commission, Lyndhurst, NJ.
M. L. Kraus.
Bulletin of the New Jersey Academy of Sciences, Vol. 33, No. 2, p 39-43, Fall 1988. 27 ref, 2 tab.

Descriptors: *Path of pollutants, *Grasses, *Heavy metals, *Spartina, *Bioaccumulation, *Salt marshes, Metals, Excretion, Metabolism, Aquatic plants.

Leaves, roots, rhizomes, and seeds, as well as excreted salts from the saltmarsh cordgrass, Spartina alterniflora, were collected in a metal polluted estuary in Lyndhurst, New Jersey. These samples as well as soil and sea salt samples were analyzed for Cd, Pb, Cr, Cu, and Ni. Data suggests that S. alterniflora has the theoretical potential to export 145.6 g Cd, 260.0 g Pb, 104.0 g Cr, 260.0 g Cu, and 988.8 g Ni per ha/year through salt excretion. In addition, this grass also has the theoretical potential to export 17.2 g, 894.4 g, 285.5 g, 779.2 g and 548.2 g of Cd, Pb, Cr, Cu, and Ni respectively per ha/year through accumulation and export of metal in leaf tissue. (Author's abstract)
W89-05236

GEOCHEMICAL MONITORING OF ATMOSPHERIC HEAVY METAL POLLUTION: THEORY AND APPLICATIONS,
For primary bibliographic entry see Field 5A.
W89-05242

EFFECT OF RANDOM PRECIPITATION TIMES ON THE SCAVENGING RATE FOR TROPOSPHERIC NITRIC ACID,
National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center.
R. W. Stewart.
Tellus TELLAL, Vol. 40B, No. 4, p 285-296, September 1988. 5 fig, 1 tab, 12 ref.

Descriptors: *Acid rain, *Water pollution sources, *Hydrologic models, *Nitric acid, *Precipitation scavenging, *Volatile acids, Air pollution, Precipitation, Path of pollutants, Air-water interfaces.

Studies of the effect of averaging the continuity equation for soluble species over wet and dry periods of a precipitation cycle have shown that the effective scavenging rate which must be used in such averaged models is less than the classical value obtained by a simple average of the scavenging rate over a cycle. This is a consequence of the fact that for an intermittent loss process such as precipitation, wet periods correspond to depressed and dry periods to enhanced soluble species concentration. There is thus an inherent negative correlation between departures from the mean of the scavenging rate and soluble species concentration which is not accounted for in the averaging process. This study shows that if the source of the soluble species is time dependent, then periods of positive correlation between scavenging rate and species concentration may also result from temporal averaging. This can result when the end of a precipitation period is coincident with the diminution or termination of the source. A specific example considered is the late afternoon rainout of nitric acid occurring just prior to the night time cessation of its chemical production. Under some assumed precipitation scenarios, the positive correlation may dominate, leading to an effective scavenging rate exceeding the classical value. A model was developed to take account of the effect of random precipitation times on the nitric acid scavenging rate. These calculations give effective scavenging rates about a factor of 2 to 3 greater than those of some other published models. For small wet fractional periods, typically less than 0.1, the effective scavenging rate may exceed the classical value slightly, although the details of this calcuiation depend on the mean precipitation period and on some of the model's statistical assumptions. (Author's abstract)
W89-05243

TRACE METAL CONTAMINATION FROM BRASS FITTINGS,
Illinois State Water Survey Div., Champaign. Aquatic Chemistry Section.
For primary bibliographic entry see Field 5F.
W89-05247

PHOSPHORUS LOSSES FROM CROPLAND AS AFFECTED BY TILLAGE SYSTEM AND FERTILIZER APPLICATION METHOD,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 5G.
W89-05263

WATER QUALITY IN THE PAWTUXET RIVER: METAL MONITORING AND GEOCHEMISTRY,
Rhode Island Univ., Narragansett. Graduate School of Oceanography.
J. S. Latimer, C. G. Carey, E. J. Hoffman, and J. G. Quinn.
Water Resources Bulletin WARBAQ, Vol. 24, No. 4, p 791-800, August 1988. 3 fig, 5 tab, 14 ref.

Descriptors: *Pawtuxet River, *Geochemistry, *Wastewater treatment, *Heavy metals, *Monitoring, *Water quality, *Path of pollutants, *Fate of pollutants, *Stream pollution, *Water pollution sources, *Urban watersheds, *Rhode Island, *Model studies, Cadmium, Chromium, Copper, Lead, Nickel, Outfall, Industrial wastewater, Municipal water, Groundwater pollution, Effluents, Chemical analysis, Pollutant identification, Sediments.

The Pawtuxet River flows from a relatively rural area through some of the more highly industrialized sections of Rhode Island. During its journey, the river receives many municipal, industrial, and ground water sources of metal constituents. This report is the first of a two-part series in which the water quality of this urban river was evaluated by a chemical monitoring study of the sources, transport mechanisms, and fate of cadmium, chromium, copper, lead, and nickel in the river. The second paper will use the chemical data to derive and calibrate a steady-state water quality model for this river. The metal concentrations in the river tended to increase from the headwaters to the mouth with river stations nearest to point source outfalls showing elevated values. In some sections of the river, levels of a few of the metals could not be explained by the point sources; and other inputs, including sediment resuspension, are proposed to make up this apparent imbalance. The ability of a municipal secondary treatment plant to remove metals was demonstrated, and the tie-in of the effluent from a major chemical company to the plant did not cause any observable deterioration in treatment efficiency. (Author's abstract)
W89-05269

STREAM CHEMISTRY IN THE SOUTHERN BLUE RIDGE: FEASIBILITY OF A REGIONAL SYNOPTIC SAMPLING APPROACH,
Environmental Protection Agency, Research Triangle Park, NC.
For primary bibliographic entry see Field 7A.
W89-05272

MUNICIPAL RESPONSES TO VOLATILE ORGANIC COMPOUNDS IN WISCONSIN GROUND WATER,
Wisconsin Univ.-Milwaukee. Center for Great Lakes Studies.
For primary bibliographic entry see Field 2F.
W89-05275

PREDICTIVE CAPABILITIES OF BATCH-EXTRACT EXPERIMENTS USING WATER FROM A COAL MINE,
Geological Survey, Cheyenne, WY. Water Resources Div.
D. L. Naftz.
Water Resources Bulletin WARBAQ, Vol. 24, No. 4, p 869-877, August 1988. 4 fig, 6 tab, 20 ref.

Descriptors: *Water pollution sources, *Geochemistry, *Groundwater pollution, *Mine wastes, *Coal mines, *Model studies, Chemical properties, Water quality, On-site data collections, Chemical reactions, Thermodynamics, Sampling, Wyoming, Predictions, Minerals.

The ability of batch-extraction experiments to predict postmining groundwater quality was evaluated. As a basis for evaluation, mineralogical and water quality data were used to identify the geochemical reactions that controlled the major-ion chemistry in batch-extraction experiments. The experiments used water and spoil material collected from a surface-coal mine in the Powder River basin of northeast Wyoming. The batch-extraction experiments consisted of a 2:1 solid:liquid ratio of groundwater and spoil material (by weight). The chemical composition of the resulting batch-extracts was determined after a contact time of 24 hr. Thermodynamically-favorable reactions included calcite precipitation, gypsum dissolution, and formation of kaolinite as a result of orthoclase feldspar hydrolysis. Three reaction models were consistent with the thermodynamic and mineralogic data. In general, the extracts had smaller major-ion concentrations that did the water samples collected from the spoil aquifer. Correction ratios were calculated from these experiments and could be used in combination with additional batch-extractions at existing or future lease areas to predict the quality of the groundwater after mining. (Author's abstract)
W89-05278

WATER ACIDIFICATION BY ADDITION OF AMMONIUM SULFATE IN SEDIMENT-WATER COLUMNS AND IN NATURAL WATERS,
Katholieke Univ. Nijmegen (Netherlands). Lab. of Aquatic Ecology.
J. A. A. R. Schuurkes, J. Jansen, and M. Maessen.
Archiv fuer Hydrobiologie AHYBA4, Vol. 112, No. 4, p 495-516, June 1988. 6 fig, 3 tab, 34 ref.

Descriptors: *Natural waters, *Acidification, *Water chemistry, *Path of pollutants, *Acidic water, *Ammonium, *Sulfates, Sediment-water interfaces, Bottom sediments, Water column, Biochemistry, Denitrification, Hydrogen ion concentration, Chemical reactions.

The importance of biochemical conversions of ammonium sulfate in water acidification was studied by means of sediment-water columns at the laboratory and enclosure experiments in natural waters. Evidence is given that acidification induced by ammonium sulfate is determined by ammonium, nitrate and sulfate-related processes. The importance of various environmental factors influencing the rate and extent of these processes is experimentally supported. In sediment-water columns with circumneutral water poor in bicarbonate, above an oxidizing sandy sediment, the production of hydrogen-ions was fully explained by the nitrification process. In acid water with pH $<$ or $=$ 4.5, the rate of nitrification was reduced down to 14%. The acidifying impact of ammonium sulfate decreased in the presence of nitrogen assimilating algae and reducing sedimentary conditions. In a typical low-alkaline shallow water body with an oxidizing sediment, the nitrification process contributed significantly to the acidification by ammonium sulfate. In an acid water body with a reducing sediment, denitrification was the most important alkalinizing process. The acidification efficiency of ammonium sulfate conversions was 132% in the first, and 22% in the second type of water. It is emphasized that the effective acid production resulting from high external inputs of ammonium sulfate, e.g. by atmospheric deposition, exerts a significant pressure on the acid-base balance of low-alkaline waters. (Author's abstract)
W89-05290

SURVIVAL OF YERSINIA ENTEROCOLITICA IN THE ENVIRONMENT,
Soochow Univ., Taipei (Taiwan). Dept. of Microbiology.
W. Chao, R. Ding, and R. Chen.
Canadian Journal of Microbiology CJMIAZ, Vol. 34, No. 6, p 753-756, June 1988. 2 fig, 3 tab, 20 ref.

Descriptors: *Pathogenic bacteria, *Soil contamination, *Survival, *Path of pollutants, *Aquatic environment, *Population dynamics, Protozoa, Yersinia, Stream biota, Soil bacteria, Food chain, Ecosystems, Predation, Aquatic populations, Groundwater, Temperature effects.

When Yersinia enterocolitica was introduced into soils (or physiological saline), very little decrease in the population was observed throughout the test period. If the soil was allowed to air dry slowly, only 0.1% (2,800 colony-forming units/g of soil) of the original population added still remained viable by day 10. On the other hand, the introduced organisms disappeared rapidly in river water but their longevities could be extended significantly if a eucaryote inhibitor was added to the river water or the river water was passed through a 0.8 micrometer membrane filter to remove eucaryotic predators. Furthermore, the rapid decrease of the Yersinia population coincided with an increase in the number of protozoans. However, when Yersinia was added to filter-sterilized river water or when small numbers of the organism, below the threshold level believed necessary for active predation to occur, were added to the river water, no response in predators was observed; nevertheless, the population of Yersinia still showed a continued decline. When the organism was introduced into sephadex-treated river water or groundwater, its survival improved significantly compared with its survival in nontreated water samples. Low ambient temperature dramatically increased its ability to survive in the aquatic environment. It is concluded that, in addition to the temperature factor, the longevity of Y. enterocolitica in river water is chiefly regulated by predators and toxin producers. (Author's abstract)
W89-05300

LEGIONELLA SPP. IN PUERTO RICO COOLING TOWERS,
Puerto Rico Univ., Rio Piedras. Dept. of Biology.
A. Negron-Alvira, I. Perez-Suarez, and T. C. Hazen.
Applied and Environmental Microbiology AEMIDF, Vol. 54, No. 10, p 2331-2334, October 1988. 3 tab, 14 ref.

Descriptors: *Water pollution sources, *Pollutant identification, *Cooling towers, *Puerto Rico, *Public health, *Legionella, Human pathology, Risks, Municipal water, Air conditioning, Population density, Bacteria, Bacterial physiology, Water pollution, Pathogens, Population exposure.

Water samples from air conditioning cooling towers receiving different treatment protocols on five large municipal buildings in San Juan, P.R., were assayed for various Legionella spp. and serogroups by using direct immunofluorescence. Several water quality parameters were also measured for each sample. Guinea pigs were inoculated with water samples to confirm pathogenicity and recover viable organisms. Legionelia pneumophila serogroups 1 to 6, L. bozemanii, L. micdadei, L. dunoffii, and L. gormanii were observed in at least one of the cooling towers. L. pneumophila was the most abundant species; its density reached 100,000 cells per ml, which is within the range that is considered potentially pathogenic to humans. A significantly higher density of L. pneumophila was observed in the cooling tower water that was not being treated with biocides. Percent respiration (INT) and total cell activity (acridine orange direct count) were inversely correlated with bacterial density. This study demonstrates that Legionella spp. are present in tropical air-conditioning cooling systems and that, without continuous biocide treatment, they may reach densities that present a health risk. (Author's abstract)
W89-05301

DEGRADATION OF 2-METHYLISOBORNEOL BY AQUATIC BACTERIA,
Southern California Metropolitan Water District, La Verne. Water Quality Branch.
For primary bibliographic entry see Field 5F.
W89-05302

NEW NAPHTHALENE-DEGRADING MARINE PSEUDOMONAS STRAINS,
Universitat de les Illes Balears, Palma de Mallorca (Spain). Dept. de Biologia y Ciencias de Salud.
E. Garcia-Valdes, E. Cozar, R. Rotger, J. Lalucat, and J. Ursing.
Applied and Environmental Microbiology AEMIDF, Vol. 54, No. 10, p 2478-2485, October 1988. 3 fig, 6 tab, 43 ref.

Descriptors: *Fate of pollutants, *Bacterial analysis, *Naphthalene, *Hydrocarbons, *Aromatic compounds, *Marine sediments, *Microbial degradation, *Pseudomonas, Taxonomy, Biochemistry, Sampling, Metabolism, Organic compounds.

Over 100 strains that utilized naphthalene as the only carbon and energy source were isolated from samples of marine sediments taken from a heavily polluted area. The isolates were characterized taxonomically and physiologically. Most of these strains belonged to the genus Pseudomonas, and seven of them did not fit any previous taxonomic description. They differed from type strains in a few biochemical characteristics and in the utilization of aromatic compounds. None had catechol 1,2-dioxygenase activity, and catechol 2,3-dioxygenase was responsible for the aromatic ring cleavage. DNA hybridizations demonstrated a close relationship between two isolates and the Pseudomonas stutzeri type strain, and between five isolates and the Pseudomonas testosteroni type strain. On the basis of nutritional and enzymatic characteristics, it was assumed that the seven isolates represent new biovars belonging to the species P. testosteroni and P. stutzeri that are able to degrade aromatic hydrocarbons. (Author's abstract)
W89-05303

MICROBIAL METABOLISM OF POLYCYCLIC AROMATIC HYDROCARBONS: ISOLATION AND CHARACTERIZATION OF A PYRENE-DEGRADING BACTERIUM,
National Center for Toxicological Research, Jefferson, AR.
M. A. Heitkamp, W. Franklin, and C. E. Cerniglia.
Applied and Environmental Microbiology AEMIDF, Vol. 54, No. 10, p 2549-2555, October 1988. 4 fig, 1 tab, 45 ref.

Descriptors: *Fate of pollutants, *Bacterial analysis, *Pyrenes, *Aromatic compounds, *Hydrocarbons, *Biodegradation, *Microbial degradation, *Mycobacteria, Metabolism, Culturing techniques, Organic compounds, Biochemistry.

Microbiological analyses of sediments located near a point source for petrogenic chemicals resulted in the isolation of a pyrene-mineralizing bacterium. This isolate was identified as a Mycobacterium sp. on the basis of its cellular and colony morphology, gram-positive and strong acid-fast reactions, diagnostic biochemical tests, 66.6% guianine + cytosine content of the DNA, and high-molecular-weight mycolic acids (C58 to C64). The mycobacterium mineralized pyrene when grown in a mineral salts medium supplemented with nutrients but was unable to utilize pyrene as a sole source of carbon and energy. The mycobacterium grew well at 24 and 30 C and minimally at 35 C. No growth was observed at 5 or 42 C. The mycobacterium grew well at salt concentrations up to 4%. Pyrene-induce Mycobacterium cultures mineralized 5% of the pyrene after 6 h and reached a maximum of 48% mineralization within 72H. Treatment of induced and noninduced cultures with chloramphenicol showed that pyrene-degrading enzymes were induceable in this Mycobacterium sp. This bacterium could also mineralize other polycyclic aromatic hydrocarbons and alkyl-substituted and nitro-substituted polycyclic aromatic hydrocarbons including naphthalene, phenanthrene, fluoranthene, 3-methylcholanthrene, 1-nitropyrene, and 6-nitrochrysene. This is the first report of a bacterium able to extensively mineralize pyrene and other polycyclic aromatic hydrocarbons containing four aromatic rings. (Author's abstract)
W89-05304

IN SITU SURVIVAL OF PLASMID-BEARING AND PLASMIDLESS PSEUDOMONAS AERUGINOSA IN PRISTINE TROPICAL WATERS,
Puerto Rico Univ., Rio Piedras. Dept. of Biology.
For primary bibliographic entry see Field 2H.
W89-05305

METABOLISM OF VOLATILE CHLORINATED ALIPHATIC HYDROCARBONS BY PSEUDOMONAS FLUORESCENS,
P. A. Vandenbergh, and B. S. Kunka.
Applied and Environmental Microbiology AEMIDF, Vol. 54, No. 10, p 2578-2579, October 1988. 1 tab, 7 ref.

Descriptors: *Aliphatic hydrocarbons, *Chlorinated hydrocarbons, *Fate of pollutants, *Volatile solids, *Pseudomonas, *Microbial degradation, *Biodegradation, *Metabolism, Hydrocarbons, Organic compounds, Path of pollutants, Culturing techniques, Degradation, Bacteria, Bacterial physiology, Sampling, Industrial wastes, Waste disposal, Groundwater, Soil contamination.

The extensive use of volatile haloaliphatic hydrocarbons in industrial processes poses a substantial problem in waste disposal as they are a major source of ground water pollution. A variety of soil and water samples were obtained from a landfill site with a history of industrial contamination with two of these hydrocarbons, 1,2-dichloroehane and 1,2-dichloropropane. These samples were inoculated into a modified minimal salts medium for liquid culture enrichment and incubated for 72 h at 25 C. After enrichment and plating onto several types of media, a strain of Pseudomonas fluorescens, designated as PFL12, was cultured from the samples. This strain was then used for metabolic studies with a variety of chlorinated aliphatic hydrocarbons. It was determined that the isolate was able to metabolize 1,2-dichloroethane, 1,1,2-trichloroethane, 1,2-dichloropropane, 2,2-dichloropropane, and trichloroethylene. Such degradation observed with this strain of P. fluorescens PFL12 offers the possibility of successfully transforming this class of environmentally persistent compounds into non-toxic compounds. (Friedmann-PTT)
W89-05306

SELENATE REDUCTION BY BACTERIA FROM A SELENIUM-RICH ENVIRONMENT,
Idaho National Engineering Lab., Idaho Falls.
D. T. Maiers, P. L. Wichlacz, D. L. Thompson, and D. F. Bruhn.
Applied and Environmental Microbiology AEMIDF, Vol. 54, No. 10, p 2591-2593, October 1988. 3 fig, 1 tab, 20 ref. DOE Contract DE-AC07-76IDO1570.

Descriptors: *Path of pollutants, *Reservoirs, *Bottom sediments, *Soil chemistry, *Kesterson Reservoir, *California, *Selenium, *Microbial degradation, *Bacteria, Biochemistry, Sampling, Metabolism, On-site data collections, Biodegradation.

Samples collected from Kesterson Reservoir were screened for bacterial presence and selenate reduction capability. Selenate concentrations of 100 mg/L were not toxic to indigenous bacteria. Of the 44 samples collected, 20 possessed microbial populations capable of reducing selenate. Reduction was observed in 4% of the water samples, 92% of the sediment samples, and 100% of the soil samples. Microbial reduction of 100 mg of selenate per liter was complete within 1 week of incubation. Up to 75 mg of selenate per liter was reduced beyond selenite to an insoluble red precipitate. Data collected indicate that indigenous bacteria have a significant role in the biogeochemical cycling of selenium. (Author's abstract)
W89-05309

INFLUENCE OF HUMIC ACID ON THE TOXICITY AND BIOAVAILABILITY OF SELECTED TRACE METALS,
Northeast Louisiana Univ., Monroe. Toxicology Program.
R. A. Stackhouse, and W. H. Benson.
Aquatic Toxicology AQTODQ, Vol. 13, No. 2, p 99-107, October 1988. 2 fig, 2 tab, 23 ref.

Descriptors: *Path of pollutants, *Drilling fluids, *Waste disposal, *Toxicity, *Bioavailability, *Humic acids, *Trace elements, *Chromium, *Cadmium, Biological properties, Physicochemical properties, Daphnia, Dose-response relationships, Ecosystems, Hydrogen ion concentration.

The influence of humic acid (HA) on the toxicity and bioavailability of hexavalent chromium and cadmium was evaluated using a common freshwater invertebrate, Daphnia pulex. The 0.5, 5.0 and 50 mg HA/L concentrations had little influence on either the acute toxicity or the bioavailability of hexavalent chromium. The acute toxicity of cadmium was increased, decreased or not influenced by HA, depending on the concentration of HA and the time point examined. There was a dose-related pattern of binding (a maximal decrease in percent free cadmium followed by metal release from HA) observed with HA and cadmium. The release of cadmium from the HA may have resulted from an associated time dependent decrease in pH. (Author's abstract)
W89-05312

CALCIUM EFFECTS ON CADMIUM UPTAKE, REDISTRIBUTION, AND ELIMINATION IN MINNOWS, PHOXINUS PHOXINUS, ACCLIMATED TO DIFFERENT CALCIUM CONCENTRATIONS,
Uppsala Univ. (Sweden). Dept. of Zoology.
A. Wicklund, and P. Runn.
Aquatic Toxicology AQTODQ, Vol. 13, No. 2, p 109-121, October 1988. 1 fig, 5 tab, 39 ref.

Descriptors: *Acid rain effects, *Fate of pollutants, *Water pollution treatment, *Lake rehabilitation, *Minnows, *Bioaccumulation, *Calcium, *Cadmium, *Toxicity, Fish physiology, Biological properties, Heavy metals, Population exposure, Fish populations, Biochemistry, Metabolism, Lime, Acid waters.

A short 'pulse' of 109Cd(0.01 micrograms Cd/L) was given in synthetic experimental water to four groups of minnows, Phoxinus phoxinus, acclimated to different calcium concentrations (0.2, 0.5, 2, and 5 mM Ca). The fate of the radioactive metal within the fish was followed during an elimination period. The study was designed as an uptake-release study and the main effect of calcium was observed on the 109Cd uptake in the gills that decreased with increasing Ca levels. This caused a lower metal accumulation in the liver and kidney. Increased Ca levels resulted in a slower transfer of 109Cd from the gills to the blood indicated both by slower 109Cd elimination rates in the gills and slower accumulation rates in liver and kidney. This effect may not have been caused by Ca directly since the 109Cd transfer rate could have been dependent on the amount of 109Cd retained in the gill. Liming of acidified fresh waters increases the calcium concentrations in the water. One of the positive effects of this increase might be a lower heavy-metal uptake in fish and a subsequent decreased metal toxicity to fish. (Author's abstract)
W89-05313

INFLUENCE OF THE OCEAN ON THE CHEMISTRY OF PRECIPITATION IN NOVA SCOTIA,
Technical Univ. of Nova Scotia, Halifax. Centre for Water Resources Studies.
For primary bibliographic entry see Field 2B.
W89-05319

SULFUR ISOPTOPES IN SULFATE IN THE INPUTS AND OUTPUTS OF A CANADIAN SHIELD WATERSHED,
Department of Fisheries and Oceans, Winnipeg (Manitoba). Freshwater Inst.
R. H. Hesslein, M. J. Capel, and D. E. Fox.
Biogeochemistry, Vol. 5, No. 3, p 263-273, 1988. 3 fig, 4 tab, 20 ref.

Descriptors: *Acid rain, *Water pollution sources, *Sulfur, *Isotope studies, *Sulfates, *Path of pollutants, *Monitoring, Sorption, Catchment areas, Precipitation, Lakes, Seasonal variation.

The isotopic composition of sulfur in sulfate from precipitation, stream inflows and outflow of the Lake 239 watershed at the Experimental Lakes Area, northwestern Ontario, was monitored for four years, 1982-1985. Rainfall had lambda34S of 3-9‰ and a three-year mean value weighted by the mass of sulfate of 4.8‰. Sulfur in streams ranged from 5-15‰ and displayed a pronounced seasonal pattern in which lambda34S showed significant negative correlations with both streamflows and sulfate concentrations. Outflow values were much more constant and averaged 6.4‰ over the three-year period. Sulfate reduction or sorption favoring retention of the lighter isotope in the watershed was the probable cause of the isotopic variation of the sulfur isotopes in the streams. A sulfur isotope budget for the lake balanced within 1%. (Author's abstract)
W89-05322

COLLOIDS IN THE AQUATIC ENVIRONMENT,
Freshwater Biological Association, Ambleside (England).
For primary bibliographic entry see Field 2K.
W89-05328

FORMATION OF AMES MUTAGENICITY AND OF THE STRONG BACTERIAL MUTAGEN 3-CHLOR-4-(DICHLOROMETHYL)-5-HYDROXY-2(5H)-FURANONE AND OTHER HALOGENATED COMPOUNDS DURING DISINFECTION OF HUMIC WATER,
Abo Akademi, Turku (Finland). Dept. of Organic Chemistry.
For primary bibliographic entry see Field 5F.
W89-05331

ANTIFOULING PAINTS: USE ON BOATS IN SAN DIEGO BAY AND A WAY TO MINIMIZE ADVERSE IMPACTS,
Scripps Institution of Oceanography, La Jolla, CA. Center for Coastal Studies.
J. A. Nichols.
Environmental Management EMNGDC, Vol. 12, No. 2, p 243-247, March 1988. 4 tab, 8 ref, append. California Dept. of Boating and Waterways Agreement 86-21-13426.

Descriptors: *Pesticides, *Biocides, *Water pollution sources, *Water pollution effects, *Copper compounds, *Tin, *Antifouling agents, *Paints, Boating, Recreation, Marinas, Chemical analysis, Chemical properties, Harbors.

High concentrations of copper and tributyltin, two biocides used in antifouling paints, are found in harbors. Efforts are necessary to reduce the adverse impact of biocides from antifouling paints, but little is known about the actual use of such material. The operators of 435 boats berthed in San Diego Bay were surveyed, to determine what paints and maintenance procedures were being used. More than 90% of the respondents used conventional leaching paints. These paints contain 40% to 65% copper compounds and 3% to 7% tributyltin compounds. Few respondents used copolymer paints. Those who did use copolymer paints seemed to repaint less frequently than those using conventional leaching pains. Professional maintenance companies do not initiate repainting as frequently as individuals doing their own maintenance. It appears that the input of antifouling biocides to harbor waters could be reduced by at least one-third simply by educating boat owners about the chemical mechanisms involved in antifouling paints, by explaining the environmental and economic advantages of using slow-release paints, and by encouraging them not to repaint until their paint's useful life has expired. (Author's abstract)
W89-05341

EUTROPHICATION OF BUTTERMILK BAY, A CAPE COD COASTAL EMBAYMENT: CONCENTRATIONS OF NUTRIENTS AND WATERSHED NUTRIENT BUDGETS,
Marine Biological Lab., Woods Hole, MA.
E. Valiela, and J. E. Costa.
Environmental Management EMNGDS, Vol. 12, No. 4, p 539-553, July 1988. 7 fig, 8 tab, 37 ref.

Descriptors: *Eutrophication, *Cycling nutrients, *Estuaries, *Saline-freshwater interfaces, *Saline water, *Coastal waters, *Water pollution sources, Bays, Nitrogen, Phosphorus, Nutrients, Path of pollutants, Tidal effects, Watersheds, Adsorption.

Nutrient concentrations in Buttermilk Bay, a coastal embayment on the northern end of Buzzards Bay, MA, are higher in the nearshore where salinities are lower, suggesting that freshwater sources may contribute significantly to nutrient inputs into the bay. To evaluate the various sources, inputs of nutrients by each major source in the watershed, and into the bay itself, were estimated. Septic systems contributed about 40% of the N and P entering the watershed, with precipitation and fertilizer use adding the remainder. Groundwater transported over 85% of the nitrogen and 75% of the phosphorus entering the bay. Most nutrients entering the watershed failed to reach the bay; uptake by forests, soils, denitrification, and adsorption intercepted two-thirds of the nitrogen and nine-tenths of the phosphorus that entered the watershed. The nutrients that did reach the bay most likely originated from subsoil injections into groundwater by septic tanks, plus some leaching of fertilizers. Buttermilk Bay water has relatively low nutrient concentrations, probably because of uptake of nutrients by macrophytes and because of relatively rapid tidal flushing. Annual budgets of nutrients entering the watershed showed a low nitrogen-to-phosphorus ratio of 6, but passage of nutrients through the watershed raised N/P to 23, probably because of adsorption of PO4 during transit. The N/P ratio of water that leaves the watershed and presumably enters the bay is probably high enough to maintain active growth of nitrogen-limited coastal producers. N/P exceeded the 16:1 Redfield ratio during midwinter; the remainder of the year N/P fell below 16:1. This suggests that annual budgets do not provide sufficiently detailed data with which to interpret nutrient-limitation of producers. Further, some idea of water turnover is also needed to evaluate impact of loading rates. Urbanization of watersheds seems to increase loadings to nearshore environments, and to shift the nutrient loadings delivered to coastal waters to relatively high N-to-P ratios, potentially stimulating growth of nitrogen-limited primary producers. (Author's abstract)
W89-05343

DREDGED MATERIAL DISPOSAL MODELING IN PUGET SOUND,
Waterways Experiment Station, Vicksburg, MS.
For primary bibliographic entry see Field 5E.
W89-05345

STOCHASTIC MODELS FOR FIRST-ORDER KINETICS OF BIOCHEMICAL OXYGEN DEMAND WITH RANDOM INITIAL CONDITIONS, INPUTS, AND COEFFICIENTS,
McGill Univ., Montreal (Quebec). Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W89-05346

DETERMINATION AND CHARACTERIZATION OF CHLOROGUAIACOL CONJUGATES IN FISH BILE BY HPLC,
Joensuu Univ. (Finland). Dept. of Biology.
For primary bibliographic entry see Field 5A.
W89-05349

PARTITIONING OF INORGANIC AND ORGANIC MERCURY IN COCKLES CARDIUM EDULE (L.) AND C. GLAUCUM (BRUGUIERE) FROM A CHRONICALLY POLLUTED AREA: INFLUENCE OF SIZE AND AGE,

Marine Pollution Lab., Charlottenlund (Denmark).
F. Mohlenberg, and H. U. Riisgard.
Environmental Pollution ENPOEK, Vol. 55, No. 2, p 137-148, 1988. 4 fig, 2 tab, 22 ref.

Descriptors: *Mercury, *Path of pollutants, *Mollusks, *Bioaccumulation, *Marine environment, Accumulation, Water pollution, Denmark, Food chains, Environment, Photometry, Atomic absorption photometry, Heavy metals.

Partitioning of inorganic and organic mercury was studied in the cockles Cardium edule and C. glaucum sampled in a chronically polluted area in the Western Limfjord, Denmark. The proportion of organic mercury in the cockles was linearly correlated to age (and weight) but not to total mercury concentration in the cockles. In 2-, 3-, and 4-year-old cockles, organic mercury constituted c. 30%, 60%, and 90% of total mercury, respectively. The age correlated proportion of organic mercury is related to the food chain. Biomagnification of methylmercury might be expected to overshadow the effects of age in predacious fish, however, primary consumers, such as cockles feed on planktonic algae that have a low proportion of methylmercury. In addition, suspension-feeding bivalves, transport large volumes of water through their gills, however only 0.1% of mercury is in the methyl form. If depuration is neglected, the relative instantaneous accumulation rate would be 10 times higher for methylmercury than for inorganic mercury. Taking elimination into account, the more rapid depuration of inorganic mercury compared to organic mercury predicts that organic mercury will constitute an ever increasing proportion of total mercury in cockles as they get older. (Author's abstract)
W89-05354

TRIBUTYLTIN CONTAMINATION AROUND AN OIL TERMINAL IN SULLOM VOE (SHETLAND),
Napier Coll. of Commerce and Technology, Edinburgh (Scotland).
S. K. Bailey, and I. M. Davies.
Environmental Pollution ENPOEK, Vol. 55, No. 3, p 161-172, 1988. 3 fig, 1 tab, 18 ref. Dept. of the Environment Contract PECD 7/8/90.

Descriptors: *Tributyltin, *Metal organic pesticides, *Water pollution sources, *Oil tankers, *Bioindicators, *Coastal waters, *Pesticides, Organic pesticides, Contamination, Indicators, Water pollution effects, Mollusks, Tissue analysis, Chemical analysis, Environment, Marine environment, Pollutant identification, Fate of pollutants, Tin.

Tributyltin (TBT) contamination of coastal waters was investigated close to an oil terminal handling large tankers. Dogwhelk populations from Sullom Voe, Shetland have been examined for the development by females of certain male sexual characteristics (e.g., a penis and vas deferens). This condition, termed imposex, is a response to exposure to tributyltin compounds, and can be quantified by use of the relative penis size index (RPSI). Dogwhelk populations throughout Sullom Voe were strongly affected by TBT (RPSI 34 to 81%), and up to 90% of the females in the oil terminal area were sterile. Queen scallops collected in the Voe contained enhanced concentrations of tin in adductor muscle and gonad tissue (0.02 to 0.23 mg/kg wet weight), but it is considered unlikely that their growth and development is adversely affected. Tin was rarely detected in scallops, queens, or dogwhelks outside the Voe, although the development of a vas deferens in many of the female dogwhelks indicated a degree of contamination of the open waters of Yell Sound. TBT was detectable (2 ng/L as tin) in only two sea water samples taken from the terminal area. (Author's abstract)
W89-05355

KLEBSIELLA SPP. IN PRAIRIE AQUIFER,
Regina Univ. (Saskatchewan). Dept. of Biology.
S. H. Wong.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 41, No. 6, p 828-831, December 1988. 1 tab, 8 ref.

Descriptors: *Klebsiella, *Pathogenic bacteria, *Prairies, *Aquifers, *Public health, Culturing techniques, Bacteria, Sampling, Growth media, Microbiological studies, Drinking water, Wells, Coliforms.

The occurrence of Klebsiella in prairie aquifers was investigated in deep well water from 30 farms in Swift Current area, Saskatchewan, Canada. Membrane filtration, spread-plate, and pour-plate techniques were used to detect and enumerate total bacteria on plate count agar. All samples were found to be contaminated by bacteria. Total bacterial counts in some samples were extremely high (> 100,000 v.c./ml), with more than 4 million viable cells/ml in one well. Of the 30 wells, 73% were contaminated by coliforms and 23% by Klebsiella. However, densities of viable cells of Klebsiella were low; in only two samples did cell counts exceed 10 v.c./ml. No other coliforms except Klebsiella were found in 4 of the coliform-positive wells, suggesting that the presence of these bacteria in these deep wells was not related to fecal contamination. All of the contaminated wells were more than 100 feet deep except for well No. 13 (83 feet), which had a low bacterial count. It is concluded that this organism is of soil origin. (Doria-PTT)
W89-05358

DEGRADATION OF N-METHYLCARBAMATE AND CARBAMOYL OXIME PESTICIDES IN CHLORINATED WATER,
Hawaii Univ., Honolulu. Dept. of Agricultural Biochemistry.
C. J. Miles, M. L. Trehy, and R. A. Yost.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 41, No. 6, p 838-843, December 1988. 1 fig, 1 tab, 16 ref. EPA Grant R810973.

Descriptors: *Degradation, *Pesticides, *Carbamate pesticides, *Chlorination, *Fate of pollutants, Halogens, Chlorine, Groundwater, Groundwater pollution, Water pollution, Chromatography, Kinetics, Water treatment.

The degradation rates of the N-methylcarbamate pesticides carbaryl and propoxur and their major hydrolysis products 1-naphthol and 2-isopropoxyphenol were determined in the presence and absence of chlorinated water. Similar studies were performed with the carbamoyl oxime pesticides aldicarb and sulfoxide oxime. Chlorinated water shortened the half-lives of all the pesticides except aldicarb from 3- to 62-fold. The effect of chlorination on half-life was greater at pH 8 than pH 7, suggesting that chlorine speciation is important in degradation of these pesticides in chlorinated water. The effect of chlorinated water on the half-life of aldicarb could not be determined because of the short reaction time. The hydrolysis products were highly unstable in chlorinated water, with half-lives on the order of minutes. It is concluded that a water source contaminated with carbamate pesticides and treated by chlorination will contain lower concentrations of these pesticides in the effluent. (Doria-PTT)
W89-05359

BIOACCUMULATION OF POLYNUCLEAR AROMATIC HYDROCARBONS BY THE CLAM, RANGIA CUNEATA, IN THE VICINITY OF A CREOSOTE SPILL,
New Orleans Univ., LA. Center for Bio-Organic Studies.
I. R. DeLeon, J. B. Ferrario, and C. J. Byrne.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 41, No. 6, p 872-879, December 1988. 2 fig, 1 tab, 12 ref. NOAA Contract NA81RAC00026; US Coast Guard Contract DTCG-29-81-R-06189.

Descriptors: *Bioaccumulation, *Aromatic compounds, *Clams, *Creosote, *Path of pollutants, *Bioindicators, Accumulation, Mollusks, Water pollution, Hydrocarbons, Contamination, Chromatography, Gas chromatography, Mass spectrometry, Indicators, Monitoring, Wetlands, Bayous, Estuaries.

Bioaccumulation of polynuclear aromatic hydrocarbons (PAH) by the clam Rangia cuneata was studied in the vicinity of a creosote spill into Bayou Bonfouca at Slidell, LA. Test clams were transplanted to the study area in aluminum cages and samples at two-week intervals. Tissue samples were analyzed for PAH by gas chromatography/mass spectrometry. Clams accumulated substantial concentrations of PAH in their tissues, with the most pronounced overall increase occurring after four weeks at MS8, the station closest to the spill site. Total creosote levels measured in the water column by UV-fluorescence spectrophotometry ranged from 9 to 26 ppb. The highest level of benzopyrenes measured was 600 ppb at MS8 after four weeks, having gone from a background level of 87 ppb to 132 ppb after two weeks. It is concluded that the accumulation of creosote-derived PAH by the clam demonstrates the bioavailability of these compounds even when present in the water at trace levels. (Doria-PTT)
W89-05360

HEAVY METAL POLLUTION FROM A POINT SOURCE DEMONSTRATED BY MUSSEL (UNIO PICTORUM L.) AT LAKE BALATON, HUNGARY,
Balatoni Limnologiai Kutato Intezete, Tihany (Hungary).
For primary bibliographic entry see Field 5A.
W89-05365

APPARATUS FOR THE INVESTIGATION OF MICROBIAL REACTION RATES IN SEDIMENT SUSPENSIONS,
GKSS - Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.). Inst. fuer Chemie.
For primary bibliographic entry see Field 7B.
W89-05366

COMPETITIVE ADSORPTION OF AROMATIC NITROGEN BASES ON SUBSURFACE MATERIALS,
Battelle Pacific Northwest Labs., Richland, WA.
J. M. Zachara, and B. L. Thomas.
Available from the National Technical Information Service, Springfield, VA 22161, as DE88-000992. Price codes: A03 in paper copy, A01 in microfiche. Report No. PNL-SA--13393, August 1987. 13p, 7 fig, 3 tab, 17 ref. DOE Contract DE-AC06-76RL0 1830.

Descriptors: *Fate of pollutants, *Adsorption, *Aromatic compounds, *Nitrogen compounds, Soil contamination, Chemical analysis, Inorganic compounds, Quinoline, Hydrogen ion concentration, Pyridine, Sorption.

The inorganic sorbate pairs quinoline-acridine and quinoline-pyridine were contacted at micromolar concentrations with two low-organic subsoils to determine if competitive sorption occurred. Using quinolines as the reference compounds, competition was observed between sorbates in the acidic subsoil when the soil-water pH promoted compound ionization. Pyridine and quinoline mutually competed while acridines sorbed independently. Acridine was the least soluble and most strongly adsorbed compound and induced the greatest reduction in quinoline binding. Competitive sorption was minimal in the higher pH subsoil where the compounds are neutral. It is suggested that competition occurred between the protonated species for a subset of reactive charged sites that exhibited high affinity for the organic cations. (Author's abstract)
W89-05398

CHEMICAL QUALITY OF GROUND WATER IN SALT LAKE VALLEY, UTAH, 1969-85,
Geological Survey, Salt Lake City, UT. Water Resources Div.
K. M. Waddell, R. L. Seiler, and D. K. Solomon.
Utah Department of Natural Resources Technical Publication No. 89, 1987. 56p, 15 fig, 5 tab, 14 ref, 3 plates in pocket.

Descriptors: *Water quality, *Groundwater pollution, *Mine wastes, *Groundwater quality, *Salt Lake Valley, *Water pollution sources, Utah, Aquifers, Water quality, Dissolved solids, Chlorides, Sulfates, Iron, Uranium, Chemical analysis, Saline water, Leachates, Irrigation water, Domestic water, Groundwater movement.

During 1979-84, 35 wells completed in the principal aquifer in the Salt Lake Valley, Utah, that had been sampled during 1962-67 were resampled to determine if water quality changes had occurred. The dissolved solids concentration of the water from 13 of the wells has increased by more than 10% since 1962-67. Much of the groundwater between the mouth of Bingham Canyon and the Jordan River about 10 miles to the east has been contaminated by seepage from reservoirs and evaporation ponds associated with mining activities. Many domestic and irrigation wells yield water with concentrations of dissolved solids that exceed 2,000 mg/L. Groundwater underlying a part of the community of South Salt Lake near the Jordan River has been contaminated by leachate from uranium-mill tailings. The major effect of the leachate from the tailings of the Vitro Chemical Co. on the water in the shallow unconfined aquifer downgradient from the tailings was the contribution of measurable quantities of dissolved solids, chloride, sulfate, iron, and uranium. The concentration of dissolved solids in uncontaminated water was 1,650 mg/L, whereas downgradient from the tailings area, the concentrations ranged from 2,320 to 21,000 mg/L. The maximum volume of contaminated water was estimated to be 7,800 acre-ft. A calibrated 3-dimensional, groundwater flow model was used to simulate potential changes in the potentiometric surface due to hypothetical groundwater withdrawals from a postulated well field in the vicinity of the Salt Lake International Center. Using a pumping rate of 30 cu ft/sec, it would require about 4,900 years for the saline groundwater from beneath the lake to travel the 7 miles to the postulated well field. (Lantz-PTT)
W89-05411

HYDROLOGY AND WATER QUALITY OF DELAVAN LAKE IN SOUTHEASTERN WISCONSIN,
Geological Survey, Madison, WI. Water Resources Div.
S. J. Field, and M. D. Duerk.
Water-Resources Investigations Report 87-4168, August 1988. 61p, 28 fig, 18 tab, 62 ref.

Descriptors: *Water pollution, *Lake restoration, *Water quality, *Hydrology, *Wisconsin, *Eutrophic lakes, Recreation, Algae, Monitoring, Streamflow, Phosphorus.

Delavan Lake is a eutrophic, recreational lake in a densely populated area of southeastern Wisconsin. Sewage effluent and septic tank drainage were diverted out of the drainage basin of the lake to improve its water quality in 1981. The worst known blue-green algal bloom occurred in the lake in the summer of 1983. A comprehensive hydrologic and water quality investigation was started in October 1983 to determine why the water quality in the lake apparently had not improved after cessation of influxes of wastewaters. The in-lake phosphorus mass during the 2-year study shows a gradual declining trend that suggests an improving lake condition but also could be due to a random phosphorus decline. Future monitoring will be needed to determine whether the decline in phosphorus has indeed occurred as a result of wastewater diversion. Continuous streamflow and water quality monitoring in the subbasins of the Delavan Lake watershed showed a wide range of annual phosphorus and nitrogen yields during the study. Jackson Creek tributary, which predominantly drains the city of Elkhorn, had the highest average yields of phosphorus (838 pounds/sq mi) and Kjeldahl nitrogen (3,600 pounds/sq mi). External loading of phosphorus and nitrogen were sufficient to cause eutrophic conditions. Internal loading of phosphorus was more than two times the external phosphorus supply. Most of the internal loading occurred when the hypolimnion was anoxic during summer. Internal loading of phosphorus was more than two times the external phosphorus loadings of phosphorus during the 1985 water year was significantly reduced from that of 1984 because of a shorter anoxic period. (Lantz-PTT)
W89-05424

ACID RAIN: RHETORIC AND REALITY,
Lancaster Univ. (England). Dept. of Geography.
C. C. Park.
Methuen and Co., New York. 1987. 272p.

Descriptors: *Air pollution effects, *Path of pollutants, *Acid rain, *Fate of pollutants, *Water pollution sources, *Water pollution effects, Environmental effects, Groundwater, Runoff, Soil contamination, Acidification, Ecological effects, Sulfur, Nitrogen.

Acid rain is now one of the most serious environmental problems in developed countries. Emissions and fallout were previously extremely localized, but since the introduction of 'tall stacks' policies in both Britain and the United States--paradoxically to disperse particulate pollutants and hence reduce local damage--emissions are now lifted into the upper air currents and carried long distances downwind. The acid rain debate now embraces many western countries--including Canada, the United States, England, Scotland, Wales, Sweden, Norway, Denmark, West Germany, the Netherlands, Austria, Switzerland--and a growing number of eastern countries--including the Soviet Union, Poland, East Germany, and Czechoslovakia. The problem of acid rain arises, strictly speaking, not so much from the rainfall itself as from its effects on the environment. Runoff affects surface water and groundwater, as well as soils and vegetation. Consequently changes in rainfall acidity can trigger off a range of impacts on the chemistry and ecology of lakes and rivers, soil chemistry and processes, the health and productivity of plants, and building materials, and metallic structures. The most suitable solutions to the problems of acid rain require prevention rather than cure, and there is broad agreement in both the political and scientific communities on the need to reduce emissions of sulfur and nitrogen oxides to the atmosphere. The technology now exists to make this possible. Book divisions discuss: the problem of acid rain, the science of acid rain, the technology of acid rain, and the politics of acid rain, in an effort to evaluate this growing global problem of acid rain. (Lantz-PTT)
W89-05427

OIL IN FRESHWATER: CHEMISTRY, BIOLOGY, COUNTERMEASURE TECHNOLOGY.
For primary bibliographic entry see Field 5C.
W89-05430

WATER SOLUBLE SUBSTANCES FROM HEAVY OILS AND TAR SANDS BITUMENS - AN OVERVIEW,
Alberta Univ., Edmonton. Dept. of Chemistry.
L. G. Hepler, C. Dobrogowska, and K. Kasperski.
In: Oil in Freshwater: Chemistry, Biology, Countermeasure Technology. Pergamon Press, New York, NY, 1987. Edited by John H. Vandermeulen and Steve E. Hrudey. p 3-9, 2 tab, 47 ref.

Descriptors: *Oil pollution, *Oily water, *Bitumens, *Water pollution sources, Surfactants, Water treatment, Solubility, Hydrocarbons, Oil-water interfaces.

The principal components of oils are only very slightly soluble in water. In recent years many such solubilities have been measured and it is now known that such small solubilities can be important in several ways. Partial oxidation and hydrolysis reactions of oils yield products that are moderately soluble or even highly soluble in water. Water soluble substances will be formed from oils and bitumens during various production, upgrading, and refining processes. Largely because of their effects on interfaces, these water soluble substances have important influences on oil production efficiencies, on the properties of large accumulations of tailings, and on treatment of aqueous process streams to permit cycling or disposal of water. (See also W89-W89-04530) (Author's abstract)
W89-05431

CHEMICAL AND PHYSICAL BEHAVIOUR OF HYDROCARBONS IN FRESHWATER,
Toronto Univ. (Ontario). Inst. for Environmental Studies.
D. Mackay.
IN: Oil in Freshwater: Chemistry, Biology, Countermeasure Technology. Pergamon Press, New York, NY, 1987. Edited by John H. Vandermeulen and Steve E. Hrudey. p 10-21, 6 fig, 1 tab, 32 ref.

Descriptors: *Hydrocarbons, *Toxicity, *Fate of pollutants, *Path of pollutants, *Oil pollution, Evaporation, Solubility, Photolysis, Model studies, Emulsions, Oil-water interfaces, Oil spills, Dispersants.

The behavior of hydrocarbons in freshwater systems is reviewed. There are two levels of understanding which may be sought. The less demanding is the quantification of the bulk behavior of the oil which is controlled by the interacting processes of evaporation, dissolution, photolysis, water-in-oil emulsification (i.e. mousse formation) and oil-in-water emulsification (dispersion). The second level is the quantification of the fates of individual hydrocarbons, is a prerequisite for any assessments of oil toxicity. A framework for conducting laboratory tests which may be used for prediction of environmental fate of specific-hydrocarbons is suggested. This shows that evaporation and dissolution are competitive processes, with evaporation being more rapid for all but the polycyclic aromatic hydrocarbons and photolysis products. The importance of water-to-oil volume ratios in determining the nature of water soluble fractions is emphasized. Certain chemicals of low vapor pressure and high solubility may have a high potential for causing toxicity because of their tendency to dissolve, e.g. polynuclear aromatics and oxygenated photolytic products. (See also W89-04530) (Geiger-PTT)
W89-05432

MODEL STUDIES OF THE EFFECT OF TEMPERATURE ON SPREADING RATE OF A CRUDE OIL ON WATER,
Acadia Univ., Wolfville (Nova Scotia). School of Engineering.
R. J. Palczynski.
IN: Oil in Freshwater: Chemistry, Biology, Countermeasure Technology. Pergamon Press, New York, NY, 1987. Edited by John H. Vandermeulen and Steve E. Hrudey. p 22-30, 6 fig, 2 tab, 10 ref.

Descriptors: *Oil spills, *Path of pollutants, *Oil-water interfaces, *Model studies, Mathematical models, Water temperature, Viscosity, Surface tension, Density, Cleanup operations.

One-dimensional viscous-surface tension spreading rate of oil slicks on calm water was investigated under controlled laboratory conditions. Comparison of the spreading rates of different crude oils at various temperatures is presented. The spreading rate of crude oil increased with temperature at the rate of 1.1% per degree C. Experimental data are given for the change with temperature in viscosity, surface tension, water-crude interfacial tension, and density of crude samples. The pour point of crude samples, another temperature dependent property, is also discussed. The increment in temperature of crude oils causes a decrement in its viscosity, density, surface and interface tensions while spreading rate is increasing. (See also W89-04530) (Author's abstract)
W89-05433

COMPOSITIONAL CHANGES OF TWO CRUDE OILS EXPOSED TO WEATHERING PROCESSES IN FRESHWATER LAKES AND IN LABORATORY AQUATIC MICROCOSMS,
Utah Water Research Lab., Logan.
M. E. Pitts, V. D. Adams, and M. D. Werner.
IN: Oil in Freshwater: Chemistry, Biology, Countermeasure Technology. Pergamon Press. New York, NY, 1987. Edited by John H. Vandermeulen and Steve E. Hrudey. p 31-41, 5 fig, 5 tab, 14 ref.

Descriptors: *Oil spills, *Oil pollution, *Fate of pollutants, *Weathering, Biodegradation, Lakes, Sedimentation, Gas chromatography, Microbial degradation, Hydrocarbons.

Wyoming and South Louisiana crude oils were weathered in two Western United States freshwater lakes over a period of one year and in laboratory three-phase, freshwater microcosms over a period of 48 days. The compositional changes in the weathered crude oil samples were investigated at different times. The lake-weathered oils showed a substantial decrease in the more volatile, lighter molecular weight compounds after 7 days, and the oils continued to weather as shown by analysis of samples taken after 100 days. The microcosm oil samples showed little loss of the more volatile compounds because of a closed gaseous phase condition, but showed loss of heavier compounds probably by agglomeration and sedimentation. (See also W89-04530) (Author's abstract)
W89-05434

ENVIRONMENTALLY RELEVANT CHARACTERISTICS OF OIL-IN-WATER EMULSIONS,
Alberta Univ., Edmonton. Dept. of Civil Engineering.
S. E. Hrudey, and S. Kok.
IN: Oil in Freshwater: Chemistry, Biology, Countermeasure Technology. Pergamon Press, New York, NY, 1987. Edited by John H. Vandermeulen and Steve E. Hrudey. p 58-70, 4 fig, 1 tab, 26 ref.

Descriptors: *Oil-water interfaces, *Wastewater treatment, *Oil, *Oil spills, *Emulsions, Waste characteristics, Hydrocarbons, Toxicity, Industrial wastewater, Flocculation, Surface tension, Surfactants, Particle size.

Many environmental studies involve working with oil-in-water emulsions. Considerable interest has been directed to the biological effects of the water-accommodated fractions of various crude oils and petroleum products. While it is recognized that such mixtures consist of both truly dissolved hydrocarbons and of dispersed micro-droplets, the extent and characteristics of the latter are rarely detailed in the experimental results. Since the interactions between oil and organisms are bound to be different for dissolved versus dispersed oils, consideration of the characteristics and behavior of oil-in-water emulsions should be an integral part of any biological studies on water-accommodated oil fractions. Many industrial sources of oily discharge to the environment must deal with oil-in-water emulsions. Successful treatment requires adequate characterization of emulsion properties to allow efficient destabilization and oil-water separation. A general understanding of the basic theory and behavior of oil-in-water emulsions is a prerequisite to sound experimental design. The theory of oil-water emulsion stability is reviewed by discussing the factors controlling proximity (electrical barriers, steric barriers), and factors controlling coalescence (mechanical properties of the interface, surfactants properties at the interface). Markedly different results were obtained in studies comparing the toxicity of oil-water dispersions with the toxicity of water soluble fractions prepared from the same reference oils. Much of the observed difference in toxicity was attributed to differences in chemical composition between oil-water dispersions and water soluble fractions. (See also W89-04530) (Geiger-PTT)
W89-05436

FORMATION OF WATER-IN-OIL EMULSIONS,
Nagasaki Univ. (Japan). Faculty of Fisheries.
S. Miyahara.
IN: Oil in Freshwater: Chemistry, Biology, Countermeasure Technology. Pergamon Press, New York, NY, 1987. Edited by John H. Vandermeulen and Steve E. Hrudey. p 71-84, 9 fig, 4 tab, 44 ref.

Descriptors: *Path of pollutants, *Emulsions, *Oil-water interfaces, *Oil spills, Diffusion coefficient, Films, Flotsam, Chemical properties, Fate of pollutants, Path of pollutants.

When crude oil is spilled on water, a variety of complex interactions occur. The chemical and physical processes involved determine the fate and effect of the oil spill on the aquatic environment. Research on these processes is reviewed with an emphasis on relevant Japanese studies. When oil is spilled on water, the greatest fraction will spread out on the surface, at least at first, primarily under the influence of gravity. At the same time, smaller fractions evaporate into the overlying atmosphere, and become distributed downward into the water column. When the spreading film thickness goes below 8 mm, gravity no longer influences the oil's diffusive forces, and characteristics of the film will begin to control the oil's behavior. Thin films of spilled crude oil tend to spread very quickly. The spreading is influenced by several physical and chemical factors, besides inherent differences in the oils. These include such physical factors as wind, rain, wave action, temperature, pH of the water, and air pressure, and such chemical factors as the presence and nature of other contaminants in the water surface. Using the relationship between surface pressure of an oil film and the area per molecule to surface area of an oil film, the thicknesses of several types of condensed films were calculated. When oil is spilled on the sea surface, it can form water-in-oil and oil-in-water emulsions. Where the surface tension of oil is greater than the surface tension of the water, the oil disperses in droplets into the water and conditions will favor oil-in-water emulsions. With most oils, the surface tension of the oil is less than that of water, so that wind and wave action on the oil will favor the water-in-oil type emulsions. In general, medium oils form a dark chocolate-colored emulsion, or mousse form. When mousse is formed, the volume of crude oil expands to over five times its original volume. Finely particulate oil, dispersed in the water column can also be precipitated downward by adsorption onto other sedimentary suspended material, or by electrolytic stabilization. (See also W89-04530) (Geiger-PTT)
W89-05437

WATER SOLUBILITY BEHAVIOR OF HYDROCARBON MIXTURES - IMPLICATIONS FOR PETROLEUM DISSOLUTION,
Virginia Inst. of Marine Science, Gloucester Point.
D. R. Burris, and W. G. MacIntyre.
IN: Oil in Freshwater: Chemistry, Biology, Countermeasure Technology. Pergamon Press, New York, NY, 1987. Edited by John H. Vandermeulen and Steve E. Hrudey. p 85-94, 2 fig, 7 tab, 18 ref.
U. S. Air Force Office of Scientific Research Grant AFOSR-83-0036.

Descriptors: *Hydrocarbons, *Path of pollutants, *Fate of pollutants, *Oil spills, *Oil pollution, Salts, Dissolved solids, Organic matter, Solubility, Oil-water interfaces.

Water solubilities of binary and multicomponent hydrocarbon mixtures were determined at 20 C to elucidate the role of the dissolution process in the fate of a petroleum spill in the aquatic environment. Equilibrium and non-equilibrium solute concentrations were determined by solvent extraction and gas chromatography. The results indicate that equilibrium aqueous phase concentrations can be predicted using knowledge of the hydrocarbon phase composition, water solubilities of single components and hydrocarbon phase interactions. Estimates of component activity coefficients in the hydrocarbon phase from binary mixture solubility data were used to predict solute concentrations for two 12-component simulated jet fuel mixtures. The predicted solute concentrations were generally well within 10% of the observed values. Solute concentration ratios in non-equilibrium situations differed only slightly from that at equilibrium. Equilibrium and non-equilibrium solubility behavior may be related, because water near the oil-water interface may reach a near-equilibrium state prior to being mixed by turbulence with undersaturated water underneath. Dissolved salts and dissolved organic material in natural waters appear not to change the relative solute concentrations resulting from equilibrium with a hydrocarbon mixture. The absolute solute concentration, however, is decreased by dissolved salts due to the salting out effect. (See also W89-04530) (Author's abstract)
W89-05438

CHRONIC HYDROCARBON DISCHARGES INTO AQUATIC ENVIRONMENTS: II. URBAN RUNOFF AND COMBINED SEWER OVERFLOWS,
Rhode Island Univ., Narragansett. Graduate School of Oceanography.
E. J. Hoffman, and J. G. Quinn.
IN: Oil in Freshwater: Chemistry, Biology, Countermeasure Technology. Pergamon Press, New York, NY, 1987. Edited by John H. Vandermeulen and Steve E. Hrudey. p 114-137, 8 fig, 6 tab, 46 ref.

Descriptors: *Hydrocarbons, *Urban runoff, *Combined sewer overflows, *Water pollution sources, Oil pollution, Particulate matter, Storm runoff, Land use.

The literature on petroleum hydrocarbon discharges from urban runoff and combined sewer overflows was reviewed with emphasis on: concentrations and mass discharge rates, factors which control these rates, chemistry of the hydrocarbons, sources and abatement of the petroleum products in urban hydrography and form of precipitation. Relationships of hydrocarbon concentrations to analytical methodology, antecedent conditions and traffic volume are unclear. In all the studies, the hydrocarbons in urban runoff were largely associated with particulates. The chemical nature of the hydrocarbons in runoff were a function of storm history and/or land use. Although a number of source materials for the hydrocarbons in runoff have been suggested, drips of crankcase oil on pavement surfaces appear to be the dominant source at most land uses. Abatement procedures demonstrated to be effective include proper maintenance of automobiles, use of oil-water separators for industrial runoff, use of specially designed drainage systems which include subsurface disposal, overland flow landscaping, retention basins and porous pavement. Combined sewer overflow data on hydrocarbons are very rare and discharge rates appear to be site specific. A modelling approach to estimate potential loadings via combined sewer overflows is discussed. Hydrocarbon pollution budgets to various receiving waters were compared. Although each budget was site specific, it appears that the total hydrocarbon budget relates to the population of the watershed. Chronic inputs of petroleum to U.S. aquatic environments is estimated at 470,000 tons/yr. (See also W89-04530) (Author's abstract)
W89-05440

ANALYSIS OF OIL AND GREASE COMPONENTS TO ASSESS THE QUALITY OF URBAN RUNOFF,
California Univ., Los Angeles. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5A.
W89-05441

CHRONIC CONTAMINATION OF LAKES BY PETROLEUM HYDROCARBONS: THE SEDIMENTARY RECORD,
Michigan Univ., Ann Arbor. Dept. of Atmospheric and Oceanic Science.
P. A. Meyers.
IN: Oil in Freshwater: Chemistry, Biology, Countermeasure Technology. Pergamon Press, New York, NY, 1987. Edited by John H. Vandermeulen and Steve E. Hrudey. p 149-160, 7 fig, 36 ref.

Descriptors: *Oil pollution, *Hydrocarbons, *Path of pollutants, *Water pollution sources, *Lake sediments, Lakes, Washington, Urban runoff, Aromatic compounds, Air pollution, Fate of pollutants, Particulate matter.

Petroleum hydrocarbons enter lake systems by a number of processes, most notably land runoff, rivers, and airborne particles, and can become part of the sedimentary record. Distributions of aliphatic and aromatic hydrocarbons in lake sediments show these two petroleum fractions do not have the same combination of transport processes. Water transports both, but atmospheric inputs are the major pathway for aromatic hydrocarbons. The record preserved in these sediments of lakes in North America and Europe parallels the history of

petroleum usage in these regions and the chronic contamination of these lakes. Petroleum hydrocarbons can remain long in lake sediments even though partial degradation of petroleum components occurs. Lakes and areas closer to urban and industrial areas contain greater amounts of petroleum hydrocarbons in their sediments than do more remote lakes. Stormwater runoff from roadways and rivers are the two main pathways by which aliphatic hydrocarbons reach lakes. Aromatic hydrocarbons are also brought to lakes in these ways, but atmospheric transport as combustion products seems to be their major route. Because they are associated with particles in both water and air, petroleum-derived hydrocarbons settle to lake bottoms to become long-lived components of the sediment record. (See also W89-04530) (Author's abstract)
W89-05442

IMMISCIBLE TRANSPORT OF HYDROCARBONS INFILTRATING IN UNCONFINED AQUIFERS,
Eidgenoessische Technische Hochschule, Zurich (Switzerland). Inst. fuer Hydromechanik und Wasserwirtschaft.
T. Dracos.
IN: Oil in Freshwater: Chemistry, Biology, Countermeasure Technology. Pergamon Press, New York, NY, 1987. Edited by John H. Vandermeulen and Steve E. Hrudey. p 161-175, 11 fig, 12 ref.

Descriptors: *Hydrocarbons, *Path of pollutants, *Unconsolidated aquifers, *Water pollution treatment, *Oil pollution, *Groundwater pollution, Capillarity, Unsaturated flow, Infiltration, Oil-water interfaces, Surface tension, Percolation, Groundwater movement, Fate of pollutants.

A phenomenological description of the movement of a hydrocarbon mass spilled at the surface of an aquifer shows that density differences, interfacial tension, wettability and thus capillary effects are the important parameters determining the distribution and the movement of hydrocarbons in the aquifer. Three immiscible phases, i.e. water, hydrocarbon, and air flow in porous media. The relation between saturation degrees and movability of these fluids, as well as a method allowing the estimation of the ultimate extent of the bulk contamination are discussed. Based on theoretical considerations and experimental evidence, practical rules for preventive and sanitation measures include extraction of hydrocarbons from a contaminated aquifer, excavation of the soil containing the hydrocarbon, or installation of one or more pumping wells or trenches as close as possible to the center of the assumed area of contamination to provide a depression of the groundwater table. (See also W89-04530) (Author's abstract)
W89-05443

INDUCED SOIL VENTING FOR RECOVERY/RESTORATION OF GASOLINE HYDROCARBONS IN THE VADOSE ZONE,
Connecticut Univ., Storrs. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5G.
W89-05444

MOBILITY OF DISSOLVED PETROLEUM-DERIVED HYDROCARBON IN SAND AQUIFERS,
Waterloo Univ. (Ontario). Inst. for Ground Water Research.
C. J. Ptacek, J. A. Cherry, and R. W. Gillham.
IN: Oil in Freshwater: Chemistry, Biology, Countermeasure Technology. Pergamon Press, New York, NY, 1987. Edited by John H. Vandermeulen and Steve E. Hrudey. p 195-214, 8 fig, 5 tab, 56 ref.

Descriptors: *Oil spills, *Oil pollution, *Hydrocarbons, *Sand aquifers, *Groundwater pollution, *Path of pollutants, Benzenes, Fate of pollutants, Biodegradation, Groundwater movement, Case studies, Sorption, Organic matter.

As an immiscible phase, a liquid petroleum product from a spill or leak generally does not travel far in the subsurface. However, soluble organic compounds derived from the immiscible phase can slowly cause widespread contamination of aquifers as a result of groundwater transport. In unconfined sand and gravel aquifers of the type commonly threatened by petroleum-product contamination, groundwater generally moves laterally at a velocity of about 0.05 to 5 m/day. Thus, years or even decades may have to pass for dissolved contaminants from the location of a spill or leak to reach off-site wells or surface water bodies. Benzene, toluene, and xylenes (BTX) are common causes of groundwater contamination. Several mechanisms control the fate of contaminants after they enter a groundwater flow regime. Dispersion causes the fringes of zones of BTX contamination to spread more extensively than would be predicted on the basis of advection alone. Biodegradation in aerobic zones sometimes causes the severity of BTX contamination to diminish, and sorption causes these compounds to move more slowly than groundwater flow. A case study of the retardation of BTX in a sand aquifer which involved two laboratory methods and one field method of measurement was conducted. Results of this study were compared to a long-term field tracer experiment in the aquifer. All experiments showed the sorption coefficients to be inversely related to the aqueous solubility of the hydrocarbons. However, BTX were all found to be very mobile under the conditions studied. A high mobility is possible in aquifers that contain very little solid-phase organic matter, a condition common to sand and gravel aquifers. (See also W89-04530) (Author's abstract)
W89-05445

BIODEGRADATION OF HYDROCARBONS IN FRESHWATER,
Alberta Univ., Edmonton. Dept. of Microbiology.
J. M. Foght, and D. W. S. Westlake.
IN: Oil in Freshwater: Chemistry, Biology, Countermeasure Technology. Pergamon Press, New York, NY, 1987. Edited by John H. Vandermeulen and Steve E. Hrudey. p 217-230, 3 tab, 59 ref.

Descriptors: *Biodegradation, *Hydrocarbons, *Oil pollution, *Fate of pollutants, Microbial degradation, Bacteria, Fungi, Yeasts, Aromatic compounds, Path of pollutants, Nutrients, Case studies, Species diversity.

Bacteria, yeasts and filamentous fungi are the most important hydrocarbon degraders in freshwater systems, and the ability to degrade hydrocarbons is widespread throughout these groups. The proportion of the microbial population capable of oil degradation is influenced by environmental conditions as well as by historical exposure to hydrocarbons. In several cases, this biodegradative capability has been shown to be plasmid mediated. While the majority of research literature deals with aspects of oil degradation in a marine environment, the factors influencing biodegradation in freshwater systems are the same, namely: the physical state and chemical properties of the oil, ambient temperature, nutrient supply, aeration, and pH. The physical state of the oil determines its availability to microbes, while the chemical properties determine susceptibility to attack. Nutrient status and aeration can be the most important factors in environmental degradation of hydrocarbons since very little degradation proceeds under anaerobic or nutrient-limited conditions. Of the hydrocarbon compounds in oil, members of the saturate and aromatic fractions are most readily degraded. Low molecular weight compounds are more readily utilized than high molecular weight, complex ones. The higher the degree of substitution of a molecule with methyl or chlorine groups, the more resistant it will be to biodegradation by natural microbial flora. The products of microbial attack of hydrocarbons can be CO2, cells, low molecular weight compounds usually richer in oxygen, and unaltered hydrocarbons. This is a result of the fact that environmental conditions are usually not optimal for the complete conversion of biodegradable hydrocarbons to cellular material and that most of the hydrocarbons in oil are not susceptible to short-term microbial alteration. The introduction of hydrocarbons into freshwater aquatic systems will result in changes in the microbial composition. Hydrocarbons will be toxic to some species, other species will be unaffected while some will grow obtaining energy and cell carbon at the expense of biodegradable hydrocarbons. The net result from the introduction of hydrocarbons (i.e. pollution) is a reduction in the number of species present (i.e. a decrease in species diversity index). (See also W89-04530) (Author's abstract)
W89-05446

FATE OF POLYNUCLEAR AROMATIC HYDROCARBONS IN SOIL,
Environmental Protection Service, Burlington (Ontario). Waste Water Technology Centre.
T. L. Bulman, S. Lesage, P. Fowlie, and M. D. Webber.
IN: Oil in Freshwater: Chemistry, Biology, Countermeasure Technology. Pergamon Press, New York, NY, 1987. Edited by John H. Vandermeulen and Steve E. Hrudey. p 231-251, 10 fig, 4 tab, 17 ref.

Descriptors: *Aromatic compounds, *Hydrocarbons, *Soil contamination, *Fate of pollutants, Adsorption, Microbial degradation, Kinetics, Volatility, Path of pollutants.

A study was performed on the persistence of selected polynuclear aromatic hydrocarbons (PAH's) in soil. Two incubation studies were performed. In the first, a mixture of eight PAH's (naphthalene, phenanthrene, anthracene, fluoranthene, pyrene, benzo(a)anthracene, chrysene and benzo(a)pyrene) were added to unacclimated soil at levels of 5 and 50 mg/kg and the concentrations were monitored with time. In the second, C14-labelled benzo(a)pyrene or anthracene was added to soil incubated in biometer flasks. Microbial degradation, physical and chemical degradation, volatilization and binding were assessed as mechanisms affecting benzo(a)pyrene and anthracene in soil. The disappearance of PAH's appeared to be related to molecular weight, water solubility, volatility and adsorptivity to soil. Naphthalene disappeared rapidly from soil. Phenanthrene, anthracene, pyrene and fluoranthene were reduced by 94 to 98% during an initial period of 200 days or less. The loss during this initial period approximated first order kinetics, in some cases following a lag period. The remaining 2-6% of the added PAH's, however, was lost at a much reduced rate. With the 50 mg/kg level of application, reduced rates of disappearance in later stages resulted in levels five to ten times the background concentration which persisted throughout the 400 days. Degradation of phenanthrene, anthracene, fluoranthene and pyrene at the 5 mg/kg application rate, however, resulted in concentrations close to background levels within 400 days. Either a model other than first order or a combination of two models was required to adequately describe the loss of 99% of the added PAH's. Losses of benzo(a)anthracene, chrysene and benzo(a)pyrene ranged from 22 to 88% in 400 days. The disappearance of benzo(a)anthracene approximated first order kinetics over the 400-day period. That of chrysene and benzo(a)pyrene, however, approximated zero order kinetics. The mechanisms leading to a decrease in PAH concentration, identified through the use of C14 labelling, were predominantly volatilization and adsorption to soil solids for anthracene and adsorption to soil solids for benzo(a)pyrene. Microbial transformation of benzo(a)pyrene was minimal. (See also W89-04530) (Author's abstract)
W89-05447

REVIEW OF OIL AND BIOLOGICAL COMMUNITY RESPONSES IN NORTHERN RIVERS,
Dominion Ecological Consulting Ltd., Calgary (Alberta).
For primary bibliographic entry see Field 5C.
W89-05453

NATURAL DETOXIFICATION AND COLONIZATION OF OIL SANDS TAILINGS WATER IN EXPERIMENTAL PITS,
Syncrude Canada Ltd., Edmonton (Alberta).
H. Boerger, and M. Aleksiuk.
IN: Oil in Freshwater: Chemistry, Biology, Coun-

termeasure Technology. Pergamon Press, New York, NY, 1987. Edited by John H. Vandermeulen and Steve E. Hrudey. p 379-387, 6 fig, 1 tab, 16 ref.

Descriptors: *Water pollution treatment, *Toxicity, *Detoxification, *Oil pollution, *Oil spills, *Biodegradation, *Fate of pollutants, Trout, Daphnia, Aquatic life, Hydrocarbons, Microbial degradation, Chemical properties, Phenols, Industrial wastes.

Naturally-occurring detoxification and colonization of tailings water, resulting from the extraction of bitumen from oil sand and its subsequent upgrading to synthetic crude, has been followed for one year in two experimental pits each with a volume of 300 cu m and a depth of 3 m. During this period there were significant reductions in the concentration of toxic substances. Survival of trout and Daphnia over a 4-day test period has increased from 0% at the start to 60-80% after ten months. The pits were colonized fairly rapidly by aquatic organisms. Several detoxification processes have been identified. Use of natural detoxification in treatment and discharge of excess tailings pond water appears to warrant further study. (See also W89-04530) (Author's abstract)
W89-05455

OIL AND POLYNUCLEAR AROMATIC HYDROCARBON CONTAMINATION OF ROAD RUNOFF - A COMPARISON OF TREATMENT PROCEDURES,
Imperial Coll. of Science and Technology, London (England). Dept. of Civil Engineering.
For primary bibliographic entry see Field 5G.
W89-05463

INFLUENCE OF UNDERGROUND OPENINGS ON GASOLINE SPILL MIGRATION AND RECOVERY IN DOWNTOWN EDMONTON,
O'Connor (M.J.) and Associates Ltd., Calgary (Alberta).
R. D. King.
IN: Oil in Freshwater: Chemistry, Biology, Countermeasure Technology. Pergamon Press, New York, NY, 1987. Edited by John H. Vandermeulen and Steve E. Hrudey. p 485-491, 6 fig, 6 ref.

Descriptors: *Gasoline, *Cleanup operations, *Path of pollutants, *Water pollution prevention, Hydrocarbons, Subsurface drains, Oil spills, Oil pollution, Groundwater pollution, Leakage, Drainage systems, Landslides.

The leakage of gasoline from underground storage tanks and piping in urban areas occasionally causes environmental problems some distance from the source. Often the migration of petroleum products in the subsurface is controlled by factors other than the stratigraphic or structural characteristics of the host strata. Leaked product will move along routes that offer minimum resistance to flow such as man-made fills. A leak at an Edmonton, Canada service station resulted in the migration of gasoline along a rather unique path. The leak occurred in an area overlaying an abandoned coal mine and some 20 m from the backscarp of a major active landslide. The gasoline migrated through glacial materials before entering a network of subsurface drains, installed in the 1950's and 1960's to dewater the mine and stabilize the slide. The product subsequently entered the city's storm sewer system and drained through an outfall toward the North Saskatchewan River some 300 m south and 50 m below the source area. A temporary semi-circular earth dike was constructed beneath the outfall to prevent the contamination of the river and a simple yet effective gasoline recovery system consisting of a separator with a filter scavenger was installed at the service station site. (See also W89-04530) (Author's abstract)
W89-05464

IDENTIFICATION OF THE PARAMETERS OF GROUNDWATER MASS TRANSPORT,
Bureau de Recherches Geologiques et Minieres, Orleans (France).
J. P. Sauty, and W. Kinzelbach.
IN: Groundwater Flow and Quality Modelling. D. Reidel Publishing Co., Boston. 1988. p 33-56, 16 fig, 30 ref.

Descriptors: *Mass transfer, *Solute transport, *Groundwater movement, *Path of pollutants, Aquifers, Tracers, Field tests, Pollutant identification, Porosity, Permeability coefficient, Geohydrology, Model studies.

Using field observations (tracer experiments and pollution plumes), the hydrodispersive transport in aquifers and the main tracer test techniques are discussed. Various aspects of field tracer test interpretation are then considered: automatic identification vs. manual, comparison between two separate parallel layers and double porosity, the dependence of longitudinal and transverse macrodispersivities on travel time as a mean of accounting for heterogeneities and the identification of natural flow direction from multiwell tests. Tracer tests on a relatively local scale are widely used as a means to investigate transfer parameters. They can yield information on the effective porosity, the direction of flow and the local dispersion. This last parameter should not be extrapolated to larger scale unless there is evidence that the asymptotic state has been reached (isotropic case). For large distance transfer or slow movement, a geostatic approach through the spatial field of permeability should be applied in the determination of dispersion characteristics whenever its cost is affordable. Several methods can be applied in the identification of transfer parameters from tracer test data, including a simplified approach of time-dependent dispersivity. Different underlying model equations may lead to a comparably good fit of data. In this case, besides the technical performance of parameter estimation, the choice of the correct interpretation scheme on the grounds of geohydrological evidence is required. (See also W89-05465) (Lantz-PTT)
W89-05467

STATIONARY PRINCIPLES FOR FLOW AND TRANSPORT IN AQUIFERS,
Technion - Israel Inst. of Tech., Haifa.
For primary bibliographic entry see Field 2F.
W89-05471

RANDOM WALK METHOD IN POLLUTANT TRANSPORT SIMULATION,
Stuttgart Univ. (Germany, F.R.). Inst. fuer Wasserbau.
W. Kinzelbach.
IN: Groundwater Flow and Quality Modelling. D. Reidel Publishing Co., Boston. 1988. p 227-245, 14 fig, 28 ref.

Descriptors: *Random walk method, *Model studies, *Path of pollutants, *Simulation analysis, *Groundwater movement, *Solute transport, *Mathematical models, Finite element analysis, Chemical reactions, Adsorption, Case studies, Hydrocarbons, Groundwater pollution.

Standard finite difference and finite element solution methods of the pollutant transport equation require restrictive spatial discretization in order to avoid numerical dispersion. The random walk method offers a robust alternative if for reasons of calculational effort discretization requirements cannot be met. The method is discussed for the case of an ideal tracer starting out from the Ito-Fokker-Planck-equation. Features such as chemical reactions and adsorption can be incorporated. Besides being an alternative to other solution methods for the classical transport equation the random walk deserves attention due to its generalizability allowing the incorporation of non-Fickian dispersion. A shortcoming of the method results from the general roughness of simulated distributions in space and time due to statistical fluctuations and resolution problems. The method is applied to a field case of groundwater pollution by chlorohydrocarbons. (See also W89-05465) (Author's abstract)
W89-05480

MODELING OF SOLUTE TRANSPORT WITH THE RANDOM WALK METHOD,
Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands).
G. J. M. Uffink.
IN: Groundwater Flow and Quality Modelling. D. Reidel Publishing Co., Boston. 1988. p 247-265, 8 fig, 15 ref.

Descriptors: *Solute transport, *Random walk method, *Model studies, *Groundwater movement, *Mathematical models, Hydrologic models, Convection, Dispersion.

Flow models for convective flow may be easily by extended with a dispersive flow component by the random-walk method. The random-walk process is described by the Fokker-Planck equation. Comparison with the convection-dispersion equation shows an additional convective term in the Fokker-Planck equation that depends on the spatial derivative of the dispersion coefficient. This term is usually small but dominates when the groundwater flow itself approaches zero, as occurs e.g. near stagnation points. In situations with rotational flow this term is significant in transversal direction. (See also W89-05465) (Author's abstract)
W89-05481

ADVANCES IN MODELLING WATER-ROCK INTERACTION IN AQUIFERS,
Kiel Univ. (Germany, F.R.). Geologisch-Palaeontologisches Inst. und Museum.
For primary bibliographic entry see Field 2F.
W89-05488

PARAMETERS FOR MODELLING THE TRANSPORT OF CADMIUM AS INFLUENCED BY THE CHEMICAL PROPERTIES OF GROUND WATER AND AQUIFER MATERIAL,
Kiel Univ. (Germany, F.R.). Geologisch-Palaeontologisches Inst. und Museum.
A. Pekdeger, M. Isenbeck, J. Schroter, T. Taylor, and M. Fic.
IN: Groundwater Flow and Quality Modelling. D. Reidel Publishing Co., Boston. 1988. p 423-438, 7 fig, 5 tab, 13 ref.

Descriptors: *Path of pollutants, *Model studies, *Cadmium, *Groundwater movement, *Geochemistry, *Aquifers, Chemical properties, Geohydrology, Adsorption, Solute transport, Heavy metals, Chemical precipitation, Heavy metals, Chemical precipitation, Desorption, Hydrogen ion concentration, Porous media, Chemical reactions.

In sandy aquifer materials of Northern Germany, adsorption-desorption as well as solution-precipitation behavior of cadmium was characterized. The investigations were carried out as batch tests and in tracer experiments under saturated conditions by using different geochemical water types. The results of the batch and column tests give a general idea of mobility of cadmium. The solubility of Cd depends on the chemical properties of the water. The most important factors which lead to Cd precipitation are the HCO3-content and the pH-value. Pure adsorption/desorption behavior of Cd can be described by the Freundlich isotherm, because of its reversibility. The transport behavior of Cd in porous media is influenced by the two processes, namely adsorption/desorption and dessolution/precipitation. Therefore it greatly depends on the geochemical properties of the groundwater and the aquiter material. Carbonate content in the aquifer material leads to total precipitation; no Cd is transported. The straight-forward description of the transport velocity using retardation factors which are calculated from the Freundlich isotherm is not appropriate. The geochemical properties of the water and the aquifer material have to be included in a transport model. (See also W89-05465) (Lantz-PTT)
W89-05489

MICRO-SCALE MODELLING IN THE STUDY OF PLUME EVOLUTION IN HETEROGENEOUS MEDIA,
Waterloo Univ. (Ontario). Inst. for Ground Water Research.
E. O. Frind, E. A. Sudicky, and S. L.

Schellenberg.
IN: Groundwater Flow and Quality Modelling. D. Reidel Publishing Co., Boston. 1988. p 439-461, 12 fig, 13 ref. University Research Fellowship Grant U0508 and Operating Gran A8368.

Descriptors: *Path of pollutants, *Groundwater movement, *Heterogeneity, *Model studies, *Plumes, Aquifers, Mathematical models, Hydraulic conductivity, Dispersion.

The migration of contaminants in heterogeneous aquifers involves dispersive processes that act at different scales. The interaction of these processes as a plume evolves can be studied by micro-scale modeling whereby two scales, a local-scale or micro-scale and an aquifer-scale or macro-scale, are covered simultaneously. Local-scale dispersive processes are represented through the local dispersion coefficient in the transport equation, while larger-scale dispersion due to heterogeneities is represented through the resolution of the flow field and the diffusive exchange between streamtubes. The micro-scale model provides both the high degree of resolution compatible with local-scale processes, and the extent required for the approach to asymptotic conditions, using a grid of up to a million nodal points. The model is based on the dual potential-stream-function formulation for flow, and the transport problem is formulated in a natural coordinate system provided by the flownet. Simulations can be used to verify stochastic theories of dispersion, without the restrictive assumptions inherent in the theory. For the two-dimensional case, results indicate convergence of the effective dispersivity to the theoretical macrodispersivity value. Convergence takes place within a travel distance of about 50 correlation lengths of the hydraulic conductivity field. However, the approach taken to asymptotic conditions, as well as the macrodispersivity value, may differ for different realizations of the same medium. The influence of early-time events such as plume splitting on the asymptotic convergence remains to be investigated. (See also W89-05465) (Author's abstract)
W89-05490

MODELLING THE INCREASING DISPERSIVITY WITH FE TRANSPORT MODELS USING THE MULTILAYER CONCEPT,
Karlsruhe Univ. (Germany, F.R.). Inst. fuer Hydromechanik.
B. Herrling, and H. M. Leismann.
IN: Groundwater Flow and Quality Modelling. D. Reidel Publishing Co., Boston. 1988. p 463-474, 8 fig, 8 ref. German Research Community Grant Th 159/14.

Descriptors: *Model studies, *Dispersion, *Iron, *Groundwater movement, *Solute transport, Mathematical models, Numerical analysis, Finite element method, Simulation analysis, Tracers, Diffusivity.

A numerical model based on the finite element method for the simulation of horizontal plane transport processes in groundwater is presented. Instead of Fick's law, it uses Mercado's multilayer concept to model the dispersion. This enables a description of the scale effect of the dispersion. With additional consideration of diffusive exchange processes between the layers, a dispersivity plateau can be reached. As long as exchange processes between the layers are allowed, the arrangement of the layers has a decisive influence on the form of the breakthrough curve and on the development of the dispersion. The breakthrough curves exhibit the typically rough form which has been recorded in tracer experiments. This verifies the physical background of the given description of the dispersion. The desirable smoothness of the breakthrough curves for prognostic purposes could be achieved through an empirical modification of the diffusive exchange processes. (See also W89-05465) (Lantz-PTT)
W89-05491

RANDOM-WALK METHOD TO SIMULATE POLLUTANT TRANSPORT IN ALLUVIAL AQUIFERS OR FRACTURED ROCKS,
Strasbourg-1 Univ. (France). Inst. de Mechanique des Fluides.
P. Ackerer.
IN: Groundwater Flow and Quality Modelling. D. Reidel Publishing Co., Boston. 1988. p 475-486, 7 fig, 10 ref.

Descriptors: *Geologic fractures, *Model studies, *Random Walk method, *Path of pollutants, *Alluvial aquifers, *Fracture permeability, *Groundwater movement, *Simulation analysis, *Solute transport, Mathematical models, Porous media, Monte Carlo method, Geohydrology, Mass transfer, Porosity.

The theory of a 3-dimensional random walk method to simulate groundwater contamination can be applied to alluvial or fractured porous media in a simple way. Because it generates no numerical dispersion, the method is very competitive for three dimensional transport models where dispersivities are low (a few centimeters) and for simulation of mass transfer in fractured rocks. Good agreement between simulation and experimental data has validated the proposed model. Theoretical development generalizes the relation between apparent dispersivity coefficients and statistical properties of the flow field. In the case of a fractured porous matrix, the mass of pollutant kept by the matrix is very high compared to the injected mass. In that case, the porosity of the matrix is a sensitive parameter which quantifies the exchanges between the matrix and the fracture. It has to be taken into account in the case of stratified alluvial porous media, where differences in porosity occur. Applied in this paper to a deterministic flow field, this method is adapted to the stochastic approach of mass transfer. In each step, the velocity can be calculated as a function of its statistical distribution by using the Monte Carlo method. (See also W89-05465) (Lantz-PTT)
W89-05492

FLUID-MECHANICAL ASPECTS OF THE MIGRATION OF CHEMICALS IN FRACTURED MEDIA,
F. Schwille.
IN: Groundwater Flow and Quality Modelling. D. Reidel Publishing Co., Boston. 1988. p 515-537, 14 fig, 8 ref.

Descriptors: *Fluid mechanics, *Path of pollutants, *Groundwater movement, *Fracture permeability, Hydraulic properties, Hydraulic models, Mathematical models, Solute transport, Solubility, Density.

Based on physical models, the migration of chemicals in fractured media was investigated. The initial phase of the migration (active spreading as a result of gravity) is determined primarily from the parameters that are fluid-mechanically relevant--'miscibility with water' (corresponds to 'water solubility') and 'relative density' (relative to groundwater, which has the value 1.0). This is followed by the passive phase of migration, namely the transport of solutes out of the transition (mixing) zone through the groundwater. The connection of the two phases in a numerical model does not seem to be realizable at present. The effort would also not be justifiable because of the lack of data related to aquifers in fractured rocks. It is therefore suggested that one should try to work out simple analytical methods as an interim solution to describe both migration phases, whose results can then be connected according to one's experience. (See also W89-05465) (Author's abstract)
W89-05494

PRESENT LIMITATIONS AND PERSPECTIVES ON MODELING POLLUTION PROBLEMS IN AQUIFERS,
Geological Survey, Reston, VA.
L. F. Konikow.
IN: Groundwater Flow and Quality Modelling. D. Reidel Publishing Co., Boston. 1988. p 643-664, 4 fig, 58 ref.

Descriptors: *Path of pollutants, *Aquifers, *Model studies, Simulation analysis, Solute transport, Mathematical models, Groundwater movement, Permeability, Porosity.

In recent years there has been an increase in the use of deterministic, distributed-parameter, groundwater simulation models for analyzing contaminant transport in groundwater system. Predictive errors arising strictly from inaccuracies in the equation-solving algorithm are usually much smaller than the predictive errors associated with or produced by: (1) theoretical misconceptions or overidealizations about the system that are incorporated into the model; (2) uncertainty and error in the specification of system properties, boundary conditions, and initial conditions, and (3) uncertainty in future stresses. The next major level of improvement in groundwater simulation models will not arise from improved numerical procedures; rather, a greater investment must be made toward obtaining more accurate descriptions of aquifer properties and their variability. It is especially critical for transport models that variability in the permeability and porosity fields be defined as accurately and precisely as possible. The tradeoff between accuracy and cost will always be a difficult one to resolve, but will always have to be made for both model development and data collection. (See also W89-05465) (Author's abstract)
W89-05499

ADVANCES IN THE ASSESSMENT OF DATA WORTH FOR ENGINEERING DECISION ANALYSIS IN GROUNDWATER CONTAMINATION PROBLEMS,
British Columbia Univ., Vancouver. Dept. of Geological Sciences.
R. A. Freeze, R. Zapf-Gilje, J. Massmann, L. Cahn, and L. Smith.
IN: Groundwater Flow and Quality Modelling. D. Reidel Publishing Co., Boston. 1988. p 665-697, 3 fig, 3 tab, 36 ref.

Descriptors: *Data interpretation, *Decision making, *Groundwater pollution, *Water pollution sources, *Hydrological data, Geohydrology, Groundwater movement, Waste management, Disposal sites, Cost-benefit analysis, Economic aspects, Mathematical studies, Simulation analysis, Model studies, Hydraulic models.

This study creates a framework for the evaluation of geohydrological data worth at waste management facilities that are potential point sources of groundwater contamination. The framework is developed as a part of the engineering design process; it is based on the premise that geohydrological data have worth only if the knowledge gained can aid in making decisions between alternative courses of action. The methodology is applicable during the siting process, during facility design, and during assessment of remedial alternatives. It involves the integration of: (1) risk-cost-benefit analysis, (2) a geostatistical description of the geohydrological parameters, (3) Monte Carlo stochastic simulation, (4) sensitivity analysis, (5) variance reduction, (6) Bayesian updating, and (7) economic regret. (See also W89-05465) (Author's abstract)
W89-05500

COMPARATIVE ANALYSIS OF MATHEMATICAL MASS TRANSPORT CODES FOR GROUNDWATER POLLUTION STUDIES,
Laboratorio Nacional de Engenharia Civil, Lisbon (Portugal).
J. P. Lobo Ferreira.
IN: Groundwater Flow and Quality Modelling. D. Reidel Publishing Co., Boston. 1988. p 699-716, 2 fig, 5 tab, 8 ref.

Descriptors: *Computer programs, *Mass transfer, *Path of pollutants, *Groundwater pollution Groundwater movement, Mathematical models, Mathematical analysis, Solute transport, Geohydrology, Computer models, Finite element method, Random walk method, Comparison studies.

A comparative analysis was conducted of several mathematical codes, suitable for the solution of the convection-dispersion equation, which are based on the following mathematical methods: analytical solutions, finite state mixing cell, method of characteristics, random walk, finite elements and (only

as an introduction) boundary elements. The tests include one-dimensional and two-dimensional cases, constant and instantaneous injections and pollutants of the conservative type and with a first order decay rate. The preliminary (simplified) analysis of a new survey of mass transport in groundwaters should be carried out with models based on analytical solutions equivalent to the SA2D1.FOR program (suitable for one-dimensional, two-dimensional, or three-dimensional problems). An additional, more accurate analysis of the problem, including the detailed treatment of the boundary conditions (curvillinear boundaries, for example) can be made with the DISP4.FOR program or with any similar finite element model based on quadratic rectangular and triangular elements. Situations with a large radial component can be efficiently studied with the RANDOM.FOR model, which is based on the random walk method and on the method of characteristics. The use of a linear triangular finite element model (DISP1.FOR) is advisable when one wants to obtain responses with restricted funding and when the KONIK3.FOR program is not applicable. The MIXEL.FOR (finite element mixing cell method) is only recommended for situations where one does not have sufficient geohydrological data, especially when the longitudinal dispersion coefficient of the aquifer is not known. (See also W89-05465) (Lantz-PTT)
W89-05501

LAST STAND OF THE RED SPRUCE,
For primary bibliographic entry see Field 5C.
W89-05507

PRELIMINARY ANALYSIS OF NUTRIENT MONITORING DATA FOR THE SUSQUEHANNA RIVER AND SELECTED TRIBUTARIES: JANUARY 1, 1985 - DECEMBER 31, 1987,
Susquehanna River Basin Commission, Harrisburg, PA.
For primary bibliographic entry see Field 5G.
W89-05511

UNITED NATIONS ENVIRONMENTAL PROGRAMME: ENVIRONMENTAL DATA REPORT.
Monitoring and Assessment Research Centre, London (England).
Basil Blackwell Ltd., 108 Cowley Road, Oxford, OX4 1JF, UK. 1987. 352p.

Descriptors: *United Nations, *Data collections, *Environment, Water pollution, Population density, Climate, Public health, Wastes, Water resources development, Energy.

This book brings together, in a single volume, currently available data on the global environment. It presents reliable scientific information from identified sources all over the world in as uniform a fashion as possible. Explanatory text highlights significant emerging trends and gives enough related background information for the user to understand these trends and see their implications for the future. Worldwide data on: pollution, population, transport, climate, health, wastes, natural resources, energy, and disasters. (Lantz-PTT)
W89-05512

WATER AND SEDIMENT QUALITY IN THE CALCASIEU RIVER/LAKE COMPLEX,
McNeese State Univ., Lake Charles, LA. Dept. of Biological and Environmental Sciences.
H. E. Murray.
IN: Ecosystem Analysis of the Calcasieu River/Lake Complex (CALECO). Report No. DOE/EP/31111--1-Vol. 1, June 26, 1987. p 1-37, 20 fig, 1 tab, 5 ref.

Descriptors: *Water pollution sources, *Water pollution effects, *Water quality, *Sediments, *Calcasieu River, *Calcasieu Lake, *Louisiana, *Estuaries, Pollutant identification, Biological oxygen demand, Organic carbon, Alkalinity, Bacteria, Temperature, Dissolved oxygen, Water analysis.

A two-year (October 1983 - December 1985) intensive study of the Calcasieu River/Lake Complex was undertaken to determine the presence of anthropogenic substances, and to estimate their impacts on the estuary. Results from water measurements indicated that Bayou d'Inde had the greatest variation in BOD, TOC, alkalinity, fecal strep, temperature and DO as compared to all other sites that were sampled, while Coupique Bayou had the lowest. Pollutants measured upstream in the bayous did not appear to degrade the overall water quality of the estuary. (See also W89-05529) (Author's abstract)
W89-05530

SPECIAL POLLUTANTS,
McNeese State Univ., Lake Charles, LA. Dept. of Biological and Environmental Sciences.
H. E. Murray, and J. N. Beck.
IN: Ecosystem Analysis of the Calcasieu River/Lake Complex (CALECO). Report No. DOE/EP/31111--1-Vol. 1, June 26, 1987. p 58-101, 2 fig, 12 tab, 27 ref. DOE Grant DE-FG011-83EP31111.

Descriptors: *Louisiana, *Calcasieu River, *Calcasieu Lake, *Synthetic organic compounds, *Pollutant identification, Chemical analysis, Organic compounds, Estuaries, Water quality, Bayous, Chlorinated pesticides.

The objective of this study was to survey the Calcasieu River/Lake Complex for the presence of synthetic organic compounds, and to establish which classes of these compounds pose a potential threat to the health of the system. This two and a half year study (January 1984 - August 1986) revealed that the concentrations of all organic pollutants detected varied widely in their values. The sporadic and uneven distributions of chemical compounds appeared to be typical of what might be expected with environmental analysis of organic pollutants. The upper portion of the estuarine system (including the bayous) has the highest concentrations of pollutants (particularly the chlorinated pesticides). No single station was highest or lowest in regard to all pollutants measured. (See also W89-05529) (Author's abstract)
W89-05531

CHEMISTRY,
McNeese State Univ., Lake Charles, LA. Dept. of Chemistry.
J. N. Beck.
IN: Ecosystem Analysis of the Calcasieu River/Lake Complex (CALECO). Report No. DOE/EP/31111--1-Vol. 1, June 26, 1987. p 102-108, 3 ref.

Descriptors: *Path of pollutants, *Louisiana, *Water chemistry, *Fate of pollutants, *Water pollution effects, *Calcasieu Lake, *Calcasieu River, *Heavy metals, Mercury, Sediment contamination, Water analysis, Bioaccumulation, Nutrients, Environmental effects, Saline water intrusion, Water quality.

The Calcasieu River/Lake Complex located in southwestern Louisiana has long been affected by human activity. These impacts include the extensive channelization and dredging of the river from the Gulf of Mexico to Lake Charles. The resulting intrusion of salt water into the ship channel has adversely affected the general water quality upstream to Lake Charles. Further degradation of the general water quality has occurred due to the introduction of human waste and industrial pollutants, primarily petrochemical, and urban expansion of the area since the 1940's. The Calcasieu River/Lake Complex is also thought to be contaminated with heavy metals (i.e., mercury). However, analysis of water samples taken downstream from known outfalls often fails to show elevated concentrations of these heavy metals. The binding of these and other pollutant metals to clay particles and precipitation from the water column when contacting waters of high salinities tend to localize these pollutants in sediments near outfalls. In order to investigate the effects of the introduction of chemical pollutants on the Calcasieu River/Lake Complex, the concentrations and distribution of heavy metals, chlorinated hydrocarbons, phenols, base-neutral organic compounds and pesticides were measured in water, sediment and biota. The study focused on the portion of the Calcasieu River south of the Salt Water Barrier to Calcasieu Pass. This chapter is comprised of ten sections including this Introductory section on Chemistry. Other chapter topics are: (1) experimental methods; (2) variations of heavy metals in surficial sediments; (3) variation of mercury in surficial sediments and sediment cores; (4) variation of heavy metals in sediment cores and core chronologies; (5) uptake of heavy metals in periphyton; (6) variation of heavy metals in M. undulatus and dissected tissue from M. undulatus; (7) variation of heavy metals in various species of biota across the Calcasieu River/Lake Complex; (8) variations of radionuclides in the river/lake environment; and (9) variations of the concentrations of heavy metals and nutrients in water samples. (See also W89-05529) (Lantz-PTT)
W89-05532

HEAVY-METAL CONTAMINATION IN THE CALCASIEU RIVER/LAKE COMPLEX, LOUISIANA,
McNeese State Univ., Lake Charles, LA. Dept. of Chemistry.
J. N. Beck, G. J. Ramelow, R. S. Thompson, C. S. Mueller, and C. Webre.
IN: Ecosystem Analysis of the Calcasieu River/Lake Complex (CALECO). Report No. DOE/EP/31111--1-Vol. 1, June 26, 1987. p 124-167, 12 fig, 7 tab, 10 ref. DOE Grant DE-FG01-83EP31111.

Descriptors: *Path of pollutants, *Bayous, *Heavy metals, *Fate of pollutants, *Calcasieu River, *Calcasieu Lake, *Louisiana, *Water pollution sources, Arsenic, Cadmium, Chromium, Copper, Lead, Mercury, Silver, Zinc, Wastewater outfall.

The heavy metals As, Cd, Cr, Cu, Pb, Hg, Ag, and Zn were measured in surficial sediments at permanent stations located in the Calcasieu River/Lake Complex. The relationships among metal concentrations in different areas of the system were investigated to determine sources, source strength, and transport. The point-source inputs of heavy metals were assumed to be industrial outfalls and sewage outfalls. Although these inputs have not seriously affected the entire river/lake complex, stressed regions exist within each bayou. The heavy metal concentrations in surficial sediments had background levels of 0.60 mg/kg As, 0.3 to 1.4 mg/kg Cd, 25 mg/kg Cr, 10 mg/kg Cu, 15 mg/kg Pb, <0.05 mg/kg Hg, 0.07 mg/kg Ag, and 40 mg/kg Zn. Sewage outfalls at stations C3, D3, D7, and D8, and industrial outfalls at stations D1, D3, and V had increased metal concentrations above these background levels, but the increases were restricted to the regions near the outfalls. The metals discharged into the bayous were not being transported to the remainder of the river/lake complex. (See also W89-05529) (Author's abstract)
W89-05534

MERCURY IN THE CALCASIEU RIVER/LAKE COMPLEX, LOUISIANA,
McNeese State Univ., Lake Charles, LA. Dept. of Chemistry.
C. S. Mueller, G. J. Ramelow, J. N. Beck, and H. E. Murray.
IN: Ecosystem Analysis of the Calcasieu River/Lake Complex (CALECO). Report No. DOE/EP/31111--1-Vol. 1, June 26, 1987. p 168-185, 3 fig, 2 tab, 24 ref. DOE Grant DE-FG01-83EP31111.

Descriptors: *Mercury, *Calcasieu River, *Calcasieu Lake, *Path of pollutants, *Louisiana, Fate of pollutants, Sediment contamination, Bioaccumulation, Bayous, Wetlands.

Total Hg concentration was determined in water, sediment, and biota at selected stations throughout the Calcasieu River/Lake Complex, including three bayous that drain into the Calcasieu River. Water Hg levels were low throughout the system (<0.1 micrograms/L) and were found above detection limits only during the period from April to June 1984. Biota generally contained Hg at detectable levels (averaging about 0.25 mg/kg, dry weight). Bayou d'Inde was found to have the

heaviest burden of Hg in surficial sediment (up to 1.1 mg/kg). Mercury was not present above the detection limit of 0.005 mg/kg at stations located in Choupique Bayou and Calcasieu Lake. Core samples were collected in Bayou d'Inde to yield a profile for the changes in Hg concentration in the past. Mercury first appeared in the late 1940's, increasing during the 1960's and reaching peak concentrations in the early 1870's. At a depth of 20-28 cm, Hg had a very low concentration; below 38 cm. Hg was not detected anywhere in the estuary. (See also W89-05529) (Lantz-PTT)
W89-05535

SPATIAL AND TEMPORAL VARIATION OF HEAVY METALS IN SEDIMENT CORES FROM THE CALCASIEU RIVER/LAKE COMPLEX,
McNeese State Univ., Lake Charles, LA. Dept. of Chemistry.
C. S. Mueller, and G. J. R. J. N. Beck.
IN: Ecosystem analysis of the Calcasieu River/Lake Complex (CALECO). Report No. DOE/EP/31111--1-Vol. 1, June 26, 1987. p 186-221, 11 fig, 3 tab, 17 ref. DOE Grant DE-FG01-83EP31111.

Descriptors: *Lake Charles, *Louisiana, *Path of pollutants, *Heavy metals, *Sediment contamination, *Calcasieu River, *Calcasieu Lake, *Fate of pollutants, Bayous, Wetlands, Copper, Zinc, Chromium, Lead, Cesium radioisotopes, Tracer studies, Lead radioisotopes, Spatial distribution, Temporal distribution.

Sediment cores were obtained from several locations in the Calcasieu River/Lake Complex, including Calcasieu Lake, Calcasieu River, two bayou tributaries, and Lake Charles during the period from November 1983 to November 1985. The cores were analyzed for Cu, Zn, Cr, and Pb. The approximate sedimentation rate and a core chronology were determined by the use of 137-Cs and 210-Pb isotopes. The increase in metal concentrations after 1933, particularly along Bayou d'Inde where most industries are located, points to anthropogenic input of these metals to the system. The fact that metal concentrations tend to merge to a common value prior to 1940 throughout the system suggests that geological factors do not contribute to the observed variations in metal concentrations in this area. The background concentrations of heavy metals found in this study for the Calcasieu River/Lake Complex were: Cu (10 mg/kg), Cr (25 mg/kg), Pb (8 mg/kg), and Zn (40 mg/kg). The main emphasis of the study focused along Bayou d'Inde due to the enhanced levels of heavy metals found. The concentration of Cu in the sediments of both Bayou d'Inde and Contraband Bayou suggests a continual input of Cu up to the present. Discharge of Cr appear to have essentially stopped after 1980. Heavy metal contamination was not detected in Lake Charles. (See also W89-05529) (Lantz-PTT)
W89-05536

PERIPHYTON AS MONITORS FOR HEAVY METAL POLLUTION IN THE CALCASIEU RIVER/LAKE COMPLEX,
McNeese State Univ., Lake Charles, LA. Dept. of Chemistry.
For primary bibliographic entry see Field 5A.
W89-05537

HEAVY METALS IN SELECTED FISH, SHRIMP, AND DISSECTED TISSUE OF ATLANTIC CROAKER IN THE CALCASIEU RIVER/LAKE COMPLEX,
McNeese State Univ., Lake Charles, LA. Dept. of Chemistry.
E. F. C. C. L. Webre, G. J. Ramelow, and M. N. Beck.
IN: Ecosystem Analysis of the Calcasieu River/Lake Complex (CALECO). Report No. DOE/EP/31111--1-Vol. 1, June 26, 1987. p 243-267, 7 fig, 4 tab, 9 ref. DOE Grant DE-FG01-83EP31111.

Descriptors: *Louisiana, *Heavy metals, *Bioaccumulation, *Fish, *Shrimp, *Calcasieu River, *Calcasieu Lake, Atlantic croaker, Barium, Cobalt, Iron, Mercury, Selenium, Zinc, Tissue analysis, Kidneys, Gills, Trout, Menhaden, Spot.

Concentrations of the heavy metals Ba, Co, Fe, Hg, Sc, Se, and Zn were measured in selected dissected tissue of Atlantic croaker. Whole body, flesh, kidneys, gastrointestinal tract, and gill tissues were examined. Samples were collected throughout Calcasieu Lake and also in the Calcasieu River just above and below the lake. Large enrichments of heavy metals in the GI tract and kidneys of Atlantic croaker were found. The heavy metals were also measured in other organisms including white shrimp, and brown shrimp, as well as the following fish: gulf menhaden, silver sea trout, and spot. No variations with sampling locations were found for metal concentrations for all species. However, variations in concentrations were found in the uptake rates of certain metals; for example, mercury was significantly enriched in shrimp relative to fish species studied. (See also W89-05529) (Author's abstract)
W89-05538

VARIATIONS OF HEAVY METALS IN FISH AND OTHER ORGANISMS FROM THE CALCASIEU RIVER/LAKE COMPLEX,
McNeese State Univ., Lake Charles, LA. Dept. of Chemistry.
G. J. Ramelow, C. Webre, C. S. Mueller, J. N. Beck, and J. Young.
IN: Ecosystem Analysis of the Calcasieu River/Lake Complex (CALECO). Report No. DOE/EP/31111--1-Vol. 1, June 26, 1987. p 268-301, 3 fig, 13 tab, 25 ref. DOE Grant DE-FG01-83EP31111.

Descriptors: *Louisiana, *Bioaccumulation, *Heavy metals, *Calcasieu River, *Calcasieu Lake, *Fish, Cadmium, Arsenic, Copper, Lead, Mercury, Silver, Zinc, Tissue analysis, Zooplankton, Periphyton.

Several species of fish and other marine organisms inhabiting the Calcasieu River/Lake Complex were analyzed for As, Cd, Cr, Cu, Pb, Hg, Ag, and Zn. Concentrations for all metals measured within species and among species showed no significant variation with sampling location. Differences in elemental concentrations appear to be related to organism mobility and not to site-specific variations in metal loadings. Different species of finfish contained only trace amounts of As (<0.1 - 0.3 mg/kg), Cd (0.02 - 0.08 mg/kg), Ag (<0.01 - 0.08 mg/kg), and Pb (<0.2 - 0.5 mg/kg). Concentrations of Cu and Cr were highly variable, in contrast to Zn, which was present in relatively constant concentrations across all species (28 + or - 7 mg/kg). Sessile organisms such as oysters had the highest concentrations of heavy metals including Cd. Periphyton and zooplankton were the only groups studied that showed differences in metal concentration among sampling locations. (See also W89-05529) (Author's abstract)
W89-05539

RADIOACTIVITY IN THE CALCASIEU RIVER/LAKE COMPLEX,
McNeese State Univ., Lake Charles, LA. Dept. of Chemistry.
M. Broussard, and J. N. Beck.
IN: Ecosystem Analysis of the Calcasieu River/Lake Complex (CALECO). Report No. DOE/EP/31111--1-Vol. 1, June 26, 1987. p 302-321, 4 fig, 3 tab, 13 ref. DOE Grant DE-FG01-83EP31111.

Descriptors: *Path of pollutants, *Louisiana, *Radioactivity, *Calcasieu River, *Calcasieu Lake, *Fate of pollutants, Potassium radioisotopes, Cesium radioisotopes, Radium radioisotopes, Actinium radioisotopes, Water analysis, Brackish waters, Uranium, Thorium, Sediment contamination.

Concentrations of natural and manmade radionuclides including 40-K, 137-Cs, 226-Ra, 228-Ac, and their decay products were measured in sediment and water samples. Gross alpha and gross beta activities were also determined in water samples. The levels of radioactivity were low in all water samples, with a general increase of activity toward the brackish waters of the southern portion of the study area. The concentrations of uranium and thorium daughters found in sediment samples were relatively constant across the study area. The concentration of 40-K varied in a regular manner, with the lowest values found in the northern portion of the river/lake complex and highest values found at the southern stations. This suggests transport and deposition of potassium into the organic-rich sediments. The only manmade radionuclide found was 137-Cs which was deposited only in the top 15 to 20 cm of sediment and was uniformly distribution across the sample area. (See also W89-05529) (Author's abstract)
W89-05540

HEAVY METALS AND NUTRIENT CONCENTRATIONS IN WATER COLLECTED IN THE CALCASIEU RIVER/LAKE COMPLEX,
McNeese State Univ., Lake Charles, LA. Dept. of Chemistry.
J. N. Beck, G. J. Ramelow, C. Webre, C. S. Mueller, and R. S. Thompson.
IN: Ecosystem Analysis of the Calcasieu River/Lake Complex (CALECO). Report No. DOE/EP/31111--1-Vol. 1, June 26, 1987. p 322-348, 5 fig, 4 tab, 9 ref. DOE Grant DE-FG01-83EP31111.

Descriptors: *Louisiana, *Path of pollutants, *Heavy metals, *Nutrients, *Calcasieu River, *Calcasieu Lake, *Fate of pollutants, Arsenic, Cadmium, Chromium, Copper, Lead, Mercury, Silver, Zinc, Nitrates, Nitrites, Phosphates, Water samples, Bayous, Wetlands.

Concentrations of the heavy metals As, Cd, Cr, Cu, Pb, Hg, Ag, and Zn and the nutrients NH3, NO2 + NO3, PO4, and O-PO4 were measured in water samples at 36 stations located in the Calcasieu River/Lake Complex. Samples were collected during the period from October 1983 to May 1986. Arsenic was not found above the detection limit of 20 micrograms/L at any station. Silver was only detected in water samples collected from the Calcasieu River and Calcasieu Lake at concentrations ranging from 1 to 3 micrograms/L. Mercury was detected in water samples during the period from April to June 1984 across the study area. Concentrations of the remaining metals varied among sampling cruises but variations were not due to point sources. These variations probably resulted from changes in water quality due to storm runoff or tidal effects. Concentrations of the nutrients NH3, NO2 + NO3, PO4 and O-PO4 were relatively constant across the study area except for elevated concentrations found in Contraband and d'Inde bayous. These bayous contributed nutrients to the remainder of the Calcasieu River/Lake Complex. (See also W89-05529) (Author's abstract)
W89-05541

CHEMISTRY AND BIOLOGY OF SOLID WASTE: DREDGED MATERIAL AND MINE TAILINGS.
For primary bibliographic entry see Field 5E.
W89-05555

METALS IN AQUATIC AND TERRESTRIAL SYSTEMS: SORPTION, SPECIATION, AND MOBILIZATION,
Bureau de Recherches Geologiques et Minieres, Orleans (France). Water Resources Dept.
A. C. M. Bourg.
IN: Chemistry and Biology of Solid Waste: Dredged Material and Mine Tailings. Springer-Verlag, New York, NY. 1988. p 3-32, 5 tab, 17 fig, 132 ref.

Descriptors: *Water pollution sources, *Path of pollutants, *Metals, *Heavy metals, *Trace metals, *Metal complexes, Sorption, Speciation, Mobilization, Spoil banks, Mine wastes, Aquatic environment, Terrestrial environment.

Water is a major carrier of metal pollutants which can be transported from a disposal site both in dissolved and particulate form. In spite of their different origin, mine tailings and dredged materials present strong similarities in behavior and environmental impact. Metal sulfide minerals are signif-

icant solid phases in both waste types and pollutant remobilization will be strongly dependent on the redox reaction taking place after disposal. A detailed understanding of the mobility of metal pollutants necessitates a thorough knowledge of sorption processes, of dissolved speciation, and of their kinetics in relation to fluid flow. The mobility of metals is governed by the competition between the reactions of sorption (adsorption and/or precipitation, including co-precipitation) and of solubilization (dissolved complexation). In addition, there is some limited evidence that the participation of metals in these processes may be affected by the flow rates of the vectors of transport such as water and solid particles. (See also W89-05555) (White-Reimer-PTT)
W89-05556

MICROBIOLOGICAL OXIDATIONS OF MINERALS IN MINE TAILINGS,
Biotechnology Australia Pty Ltd., Roseville (Australia).
B. C. Kelley, and O. H. Tuovinen.
IN: Chemistry and Biology of Solid Waste: Dredged Material and Mine Tailings. Springer-Verlag, New York, NY. 1988. p 33-53, 117 ref.

Descriptors: *Water pollution prevention, *Water pollution sources, *Leaching, *Weathering, *Path of pollutants, *Mine wastes, *Mine drainage, *Acid mine drainage, Metals, Trace metals, Heavy metals, Sulfides, Microbial degradation, Oxidation process, Lime, Iron.

Acid drainage and mobilization of metals from tailings due to microbiological activity are well-recognized problems and cause major undesirable chemical and biological changes in soil and water. The formation of sulfate and ferric ions are good indicators of bacterial activity on sulfide minerals, but it is recognized that mine tailings support complex microbial consortia. Besides sulfuric acid and ferric iron production, bacterial oxidations in tailings may render extremely toxic elements soluble which pose a serious health hazard in surface and groundwater. On-site liming does not completely cease microbiological production of acid due to the microenvironments and void spaces inaccessible by liming, and the development of acidic hot spots is not an uncommon phenomenon. Such problems complicate further efforts of reclamation of tailings areas. With a view to curtailing Thiobacilli and their activities at the source, laboratory studies have demonstrated anionic surfactants and organic acids to be effective treatments. However, their use is unlikely to provide a long-lasting effect because both surfactants and organic acids are readily degraded by heterotrophic microorganisms at the site. (See also W89-05555) (White-Reimer-PTT)
W89-05557

RESPONSE OF PLANTS AND VEGETATION TO MINE TAILINGS AND DREDGED MATERIALS,
Vrije Univ., Amsterdam (Netherlands). Dept. of Ecology and Ecotoxicology.
For primary bibliographic entry see Field 5C.
W89-05558

DEVELOPMENT OF DREDGED MATERIAL DISPOSAL SITES: IMPLICATIONS FOR SOIL, FLORA AND FOOD QUALITY,
Institute for Soil Fertility, Haren (Netherlands).
W. van Driel, and J. P. J. Nijssen.
IN: Chemistry and Biology of Solid Waste: Dredged Material and Mine Tailings. Springer-Verlag, New York, NY. 1988. p 101-126, 11 tab, 6 fig, 47 ref.

Descriptors: *Path of pollutants, *Solid waste disposal, *Land reclamation, *Spoil banks, *Bioaccumulation, *Soil contamination, *Soil management, Soil-water-plant relationships, Soil sealants, Revegetation, Solid wastes, Flora, Agriculture, Cropland, Food chains, Food.

Upland disposal of dredged material yields an excellent substrate for plant growth due to high silt and organic matter contents. However, the transfer of contaminants in the dredged material to plants limits the use for agricultural purposes. The driving forces behind the transfer process from soil to plant are insufficiently understood, but accumulation differs among plant species and contaminants. In addition, soil factors such as high pH, high organic matter, and silt content tend to decrease the transfer of metals to the plant. Liming of contaminated soil may be an effective treatment if the transfer of metals is sufficiently depressed, but the use of a soil cover layer seems to be more effective. Model calculations show that with a soil cover of at least 1.0 m there is no net transfer of dissolved contaminants from the contaminated soil to the clean soil provided the groundwater level is fixed at 1 m below the surface. Experiments with plants show a decrease in the accumulation of metals by the plants, but roots of deep-rooting plants can still reach the contaminated soil layer and contribute to the metal status of the above-ground plant organs. Long-term experience with soil cover layers is not available. (See also W89-05555) (White-Reimer-PTT)
W89-05560

SOIL POLLUTION BY METALS FROM MINING AND SMELTING ACTIVITIES,
Ibaraki Univ., Ami (Japan). Faculty of Agriculture.
T. Asami.
IN: Chemistry and Biology of Solid Waste: Dredged Material and Mine Tailings. Springer-Verlag, New York, NY. 1988. p 143-169, 15 tab, 2 fig, 112 ref.

Descriptors: *Water pollution sources, *Soil contamination, *Mine wastes, *Metals, *Heavy metals, *Trace metals, Cadmium, Zinc, Lead, Copper, Arsenic, Mercury, Japan, Canada, United States, England, Western Europe, Australia, Zambia, Eastern Europe, Soviet Union, People's Republic of China.

Soil pollution by metals such as Cd, Zn, Pb, Cu, As, and Hg has been recognized in many countries. Metal pollution of soil has been found to occur from the following sources: emissions from metal mines, metal smelters, refineries, metal processing factories, coal or oil combustion facilities, municipal incinerators, automobiles; the disposal of wastes from metal mines, smelters, and refineries; the use of agricultural materials; biomass burning; and natural sources such as mineralizations and volcanic activities. Japan has severe environmental metal pollution due to high population density, a large number of metal mines, rapid economic development, and rice farming which requires irrigation with river water. One hundred twenty-six areas were above the maximum allowable limits for Cd, Cu, and/or As. In other countries, especially in Canada, U.S.A., and UK, soil pollution by heavy metals emitted as dust and fumes from the smelters has been reported. (See also W89-05555) (White-Reimer-PTT)
W89-05562

GEOCHEMISTRY OF PRIORITY POLLUTANTS IN ANOXIC SLUDGES: CADMIUM, ARSENIC, METHYL MERCURY, AND CHLORINATED ORGANICS,
Technische Univ. Hamburg-Harburg (Germany, F.R.). Arbeitsbereich Umweltschutztechnik.
M. Kersten.
IN: Chemistry and Biology of Solid Waste: Dredged Material and Mine Tailings. Springer-Verlag, New York, NY. 1988. p 170-213, 4 tab, 11 fig, 157 ref.

Descriptors: *Water pollution sources, *Water pollution prevention, *Solid waste disposal, *Sludge disposal, *Geochemistry, *Cadmium, *Arsenic, *Mercury, *Chlorinated hydrocarbons, *Biodegradation, *Fate of pollutants, *Path of pollutants, Heavy metals, Trace metals, Trace elements, Sediments, Solid wastes, Sludge.

The most intensive biogeochemical reactions are usually found in sediments where variations of the redox conditions take place. A review of various marine disposal options suggests that the best strategy for disposing of sludges is to isolate them in a permanently reducing environment, which represents a highly efficient, economic method for immobilization of heavy metals once introduced into sediment. A 'regression' of biochemical diagenetic succession from a freshwater methanic to a marine sulfidic environment affects pollutant mobility in three ways: (1) many of the trace metals and metalloids are effectively immobilized by the formation of insoluble sulfides or capture by iron sulfides; (2) the process of reduction of sulfate to sulfide is highly efficient in degrading methyl mercury, and repressing its further formation; and (3) reducing conditions are most favorable to initiate organochlorine chemical biodegradation by reductive dehalogenation processes. Evaluation of organochlorine biodegradation indicates that the use of properly selected populations of microbes (both aerobic and anaerobic) and the maintenance of environmental conditions most conducive to their metabolism, can be an important means of improving biological treatment of contaminated sludges. (See also W89-05555) (White-Reimer-PTT)
W89-05563

ASSESSMENT OF METAL MOBILITY IN DREDGED MATERIAL AND MINE WASTE BY PORE WATER CHEMISTRY AND SOLID SPECIATION,
Technische Univ. Hamburg-Harburg (Germany, F.R.). Arbeitsbereich Umweltschutztechnik.
U. Forstner, and M. Kersten.
IN: Chemistry and Biology of Solid Waste: Dredged Material and Mine Tailings. Springer-Verlag, New York, NY. 1988. p 214-237, 6 tab, 6 fig, 87 ref.

Descriptors: *Path of pollutants, *Speciation, *Mine wastes, *Spoil banks, *Heavy metals, *Trace metals, *Interstitial water, *Metals, Solid Wastes, Mine wastes, In situ dialysis.

Reactivity, mobility and availability of trace metals for metabolic processes are closely related to their chemical species both in solution and in particulate matter. In situ dialysis appears particularly well adapted to the study of trace constituents in sediment pore waters under field conditions. For the differentiation of the solid metal species, e.g. cation exchangeable forms, carbonate phases, reducible fractions, associations with organic substances and sulfides and the inert 'residual' fractions, chemical extraction sequences have been developed which can be used for estimating the potential remobilization of metals under changing environmental conditions. There is a tendency that elements introduced with solid waste material are less stably bound than those in natural systems. Even with relatively small proportions of these materials mobilization (and subsequent transfer to biota) of potentially toxic elements by acidity, complexing agents or redox changes, may be significantly increased. (See also W89-05555) (White-Reimer-PTT)
W89-05564

DIAGENETIC PROCESSES IN AQUATIC MINE TAILINGS DEPOSITS IN BRITISH COLUMBIA,
British Columbia Univ., Vancouver. Dept. of Oceanography.
T. F. Pedersen, and A. J. Losher.
IN: Chemistry and Biology of Solid Waste: Dredged Material and Mine Tailings. Springer-Verlag, New York, NY. 1988. p 238-258, 3 tab, 10 fig, 43 ref.

Descriptors: *Path of pollutants, *Diagenesis, *Mine wastes, *Solid waste disposal, Metals, Heavy metals, Trace metals, Copper, Molybdenum, Phosphate, Canada, British Columbia, Diagenetic processes, Solid wastes, Sediments, Fjords.

A two-pronged approach to diagenetic studies of mine tailings deposits in British Columbia had the following aims: to study element distributions in both the solid and dissolved states in order to extract as much information on post-depositional reactivity as possible, and to compare the results from the tailings samples with distributions in representative, proximal natural sediments. All three

of the submerged mine tailings deposits studied were not associated at the time with any serious chemical perturbation of the host natural waters. However, Mo was released from the tailings in both Rupert Inlet and in Alice Arm in contrast to the absence of significant evasion from proximal natural sediments in both areas. In both cases, the fluxes contribute only a minor proportion of the calculated inventory of the element in the fjord waters, which reflects the relatively rapid flushing rate of both inlets and the naturally high concentration of dissolved molybdenum in seawater. One of the major reasons for the absence of significant remobilization of metals other than Mo from the tailings in the deposits must be the high rate of deposition associated with high-volume discharge. The rapid burial of tailings particles limits their exposure time to oxygenated bottom water, thus inhibiting oxidation of residual sulfides in the finely-ground mill waste. (See also W89-05555) (White-Reimer-PTT)
W89-05565

BEHAVIOUR OF TRACE METALS IN A TROPICAL RIVER SYSTEM AFFECTED BY MINING,
Bougainville Copper Ltd., Panguna (Papua New Guinea).
J. Jeffery, N. Marshman, and W. Salomons.
IN: Chemistry and Biology of Solid Waste: Dredged Material and Mine Tailings. Springer-Verlag, New York, NY. 1988. p 259-274, 3 tab, 6 fig, 2 ref.

Descriptors: *Water pollution sources, *Path of pollutants, *Model studies, *Mine wastes, *Waste disposal, *Hydrologic models, Copper, Aluminum, Metals, Heavy metals, Trace metals, Geochemistry, Tropical regions, Hydrogen ion concentration, Sedimentation, Erosion, Leachates.

Since mine start-up an extensive data collection and a research program have been carried out on the waste disposal system of Bougainville Copper Limited, in Papua, New Guinea. The system operates in a high rainfall, high seismicity and mountainous zone. Information is available on the inputs to the disposal area and also on the major chemical processes that affect it. This information has been combined with hydrological and published chemical data to develop first a conceptual and then a numerical model of the chemistry of the terrestrial component of the system. The model quantifies pH, Cu, and Al throughout the river system, and contains both a hydrological and a chemical component. The model has been used to assess the factors which are most important in controlling Cu solubility in the river system and to examine both the effect of possible changes in the current tailings disposal method and the effect of various rehabilitation schemes on river chemistry and thus biology. (See also W89-05555) (White-Reimer-PTT)
W89-05566

HEAVY METAL TRANSPORT IN STREAMS--FIELD RELEASE EXPERIMENTS,
Commonwealth Scientific and Industrial Research Organization, Ryde (Australia). Div. of Fossil Fuels.
B. M. Chapman, D. R. Jones, and R. F. Jung.
IN: Chemistry and Biology of Solid Waste: Dredged Material and Mine Tailings. Springer-Verlag, New York, NY. 1988. p 275-299, 13 fig, 3 tab, 13 ref, 31 ref.

Descriptors: *Heavy metals, *Metals, *Trace metals, Streams, *Path of pollutants, Copper, Zinc, Nickel, Arsenic, Hydrogen ion concentration, Field release experiments, Advection, Dispersion, Adsorption.

The behavior of Cu, Zn, Ni, As04(3-), and H(+) have been extensively investigated in a natural, previously uncontaminated, watercourse which was artificially pumped at three different flow rates using water from a nearby stream. For an instantaneous release of solute, pulses downstream exhibited a skewed Gaussian form. However, the skewness was independent of flow rate and distance downstream. At any given distance downstream lower flow rates were comparatively more effective in dispersing the pulse than higher flow rates. This trend was also true for the chemical process of attenuation by adsorption. When metals were released together as a mixture there was no evidence of competition for available surface sites. Zinc and Ni attenuated linearly with respect to concentration; however, some of the Cu formed a colloidal suspension which did not sediment and inhibited adsorption by reducing the concentration of Cu in solution. By employing some reasonable assumptions and approximations, a simple and useful semi-empirical equation was derived to describe the effects of the processes of advection, dispersion and adsorption in this system. (See also W89-05555) (White-Reimer-PTT)
W89-05567

PREDICTIVE ASSESSMENT OF THE MIGRATION OF LEACHATE IN THE SUBSOILS SURROUNDING MINE TAILINGS AND DREDGING SPOIL SITES,
Laboratorium voor Grondmechanica, Delft (Netherlands).
M. Loxham.
IN: Environmental Management of Solid Waste: Dredged Material and Mine Tailings. Springer-Verlag, New York, NY. 1988. p 3-23, 16 fig, 19 ref.

Descriptors: *Path of pollutants, *Dredging, *Spoil banks, *Leachates, *Model studies, Mathematical models, Hydrologic models, Advection, Subsoil, Distribution patterns.

The source-path-target methodology for assessing advection effects involves the identification of the elements; source, target, and the pathway connecting them. If expected impacts at a site are unacceptable, countermeasures such as reduction or removal of the source, target movement, and pathway manipulation have to be considered. Modeling the migration patterns using the contaminant migration models requires establishing the groundwater flow pattern and calculating the developing contaminant distribution pattern using a convection-dispersion equation. The velocity (or hydraulic conductivity) that the downstream spread of the contaminant; the dispersion coefficient controls the lateral spread and the form of the downstream contaminant front; and the adsorption coefficient the time scale within which this occurs. The adsorption could delay the contaminant long enough for the decay processes to make significant inroads into the contaminant inventory on the migration paths, thereby reducing further the impact at the target. This method has achieved most success in protecting single abstraction points at the target rather than preventing significant emission from a site itself. (See also W89-05568) (White-Reimer-PTT)
W89-05569

PRE-MINE PREDICTION OF ACID MINE DRAINAGE,
Environmental Protection Service, Vancouver (British Columbia).
K. D. Ferguson, and P. M. Erickson.
IN: Environmental Management of Solid Waste: Dredged Material and Mine Tailings. Springer-Verlag, New York, NY. 1988. p 24-43, 4 tab, 3 fig, 64 ref.

Descriptors: *Leaching, *Weathering, *Path of pollutants, *Acid mine drainage, *Mine drainage, *Model studies, Geochemistry, Kinetics, Mathematical models, Prediction, Reviews.

The development and use of tests and models for the prediction of acid mine drainage are reviewed. The key factors controlling acid mine drainage are believed to be sulfide and carbonate content, reactive surface area, oxygen and water transfer rates, and bacterial activity. These factors have been used to develop predictive models of acid mine drainage. Geochemical static tests, which simply examine the balance between ac·l-producing sulfides and acid-consuming carbonates are most frequently used. Kinetic tests and mathematical models in varying complexity are used less frequently. Few verification studies have been done; however, studies conducted indicate that prediction techniques provide an insight into the possible role of acid mine drainage processes in determining mine drainage quality. Accurate predictions can be made if users recognize and consider the effect of assumptions in the technique at the mine site under study. (See also W89-05568) (White-Reimer-PTT)
W89-05570

REHABILITATION MEASURES AT THE RUM JUNGLE MINE SITE,
Australian Nuclear Science and Technology Organisation, Sutherland. Environmental Science Div.
For primary bibliographic entry see Field 5G.
W89-05576

MINE TAILINGS RECLAMATION: INCO LIMITED'S EXPERIENCE WITH THE RECLAIMING OF SULPHIDE TAILINGS IN THE SUDBURY AREA, ONTARIO, CANADA,
For primary bibliographic entry see Field 5G.
W89-05577

BIOLOGICAL ENGINEERING OF MARINE TAILINGS BEDS,
Victoria Univ. (British Columbia). Dept. of Biology.
For primary bibliographic entry see Field 5G.
W89-05579

INVESTIGATION OF THE POSSIBLE FORMATION OF DIETHYLNITROSAMINE RESULTING FROM THE USE OF RHODAMINE WT DYE AS A TRACER IN RIVER WATERS,
T. R. Steinheimer, and S. M. Johnson.
IN: Selected Papers in the Hydrologic Sciences 1986. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Supply Paper 2290. 1986. p 37-49, 7 fig, 2 tab, 34 ref.

Descriptors: *Path of pollutants, *Tracer studies, *Water pollution sources, *Nitrosamines, *Rhodamine dye, Dyes, Gas chromatography, Rivers, Monitoring, Dye releases, Water analysis, Pollutant identification.

Surface water contamination by nitrosamines formed from rhodamine WT and nitrite ion was studied. A method of residue analysis of N,N-diethyl-N-nitrosamine (NDEA) has been developed and evaluated using river samples spiked with rhodamine WT and nitrite ion. The method uses solid-phase extraction and capillary gas chromatography with N-P detectors. Reliable determination of NDEA can be determined reliably in less than 2 hr. River conditions under which rhodamine WT is introduced into a stream for time-of-travel or dispersion studies were simulated in laboratory experiments. Results show that nitrosamine formation did not occur in the spiked river samples at concentrations typically encountered during dye injection studies. NDEA persistence in river water was determined by monitoring its rate of disappearance from a spiked sample. At a concentration of approx 2 mg/l the half-life of the nitrosamine at 20 C is less than 3 hr at pH 8. Samples collected from four different rivers during actual rhodamine dye injections were analyzed for residual NDEA. Results indicate that, under customary dye-study practices, NDEA resulting from the use of rhodamine WT does not constitute an environmental hazard. (See also W89-05586) (Author's abstract)
W89-05589

ESTIMATING STREAM-AQUIFER INTERACTIONS IN COAL AREAS OF EASTERN KANSAS BY USING STREAMFLOW RECORDS,
For primary bibliographic entry see Field 2E.
W89-05590

INVESTIGATIONS OF ORGANIC CONTAMINANTS DERIVED FROM WOOD-TREATMENT PROCESSES IN A SAND AND GRAVEL AQUIFER NEAR PENSACOLA, FLORIDA,
W. E. Pereira, and C. E. Rostad.

IN: Selected Papers in the Hydrologic Sciences 1986. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. Water-Supply Paper 2290. 1986. p 65-80, 5 fig, 9 tab, 16 ref.

Descriptors: *Florida, *Hydrocarbons, *Groundwater pollution, *Creosote, *Pentachlorophenol, *Wood treatment industry, *Path of pollutants, Sand aquifers, Phenols, Nitrogen, Sulfur, Spatial distribution, Plumes.

Discharge of effluent wastes containing creosote and pentachlorophenol into surface impoundments at a wood-treatment facility has resulted in contamination of a sand and gravel aquifer near Pensacola, Florida. Six sites, consisting of 3-5 clustered wells per site, were sampled to study changes in ground-water chemistry downgradient of the impoundments and to define background concentrations of dissolved organic contaminants. Vertical and horizontal distribution of concentrations of dissolved organic carbon indicated the presence of a contaminant plume that had moved a considerable distance from the source of contamination. Analysis of ground water by gas chromatography-mass spectrometry near the source of contamination revealed the presence of approx 84 organic contaminants. Classes of compounds identified included phenols, polycyclic aromatic hydrocarbons, and heterocycles containing oxygen, nitrogen, and sulfur. A selected number of compounds from each chemical class was quantified in ground-water samples. Vertical and horizontal distributions of phenols, polycyclic aromatic hydrocarbons, and heterocycles indicated the presence of an 'oil zone,' a main contaminant plume, and a secondary contaminant plume. Two explanations for the presence of the secondary contaminant plume are postulated. The plume may have its origin in and interruption to discharge or may result from 'upconing' of the contaminant plume in the vicinity of a perennial stream. Results of the present study indicated that, in aquifer materials of low- organic carbon content (<0.1 percent), processes such as sorption are relatively insignificant, resulting in the migration of different classes of organic compounds en masse through the porous medium. (See also W89-05586) (Author's abstract)
W89-05591

HYDROGEOLOGIC FRAMEWORK FOR GROUNDWATER PROTECTION,
Wisconsin Univ.-Madison. Dept. of Geology and Geophysics.
M. P. Anderson.
In: Planning for Groundwater Protection. Academic Press, New York, NY, 1987. p 1-27, 7 fig, 2 tab, 50 ref.

Descriptors: *Path of pollutants, *Groundwater movement, *Groundwater pollution, *Subsurface water, Permeability coefficient, Soil water table, Water table, Geohydrology, Adsorption, Flow, Aquifers, Mathematical models, Groundwater recharge, Groundwater, Hydrology, Hydrologic cycle, Model studies.

Ways in which pollutants enter the groundwater system and the role of groundwater in the hydrologic cycle are discussed. The natural defense mechanisms in the subsurface which mitigate the effects of the pollution sources are described and include physical, chemical, and biological defense mechanisms. Analysis of the transport of chemicals through the soil zone to the water table requires an analysis of water movement in the unsaturated zone. The groundwater recharge rate determines the amount of water reaching the water table. The concentration of contaminants crossing the water table will be different from the concentration in leachate from the concentration in leachate emanating from the source because of dilution and degradation in the unsaturated zone. Two types of groundwater monitoring activities include protection of groundwater supplies from overdraft, and protection of groundwater from pollution. A mathematical model is presented to quantify the movement of water and solutes in the subsurface. The implications of these models for planning groundwater development include the identification of recharge zones, determination of aquifer optimal yields, and the control of groundwater degradation due to contaminant transport. (See also W89-05600) (Stoehr-PTT)
W89-05601

LONG ISLAND CASE STUDY,
Long Island Regional Planning Board, Hauppauge, NY.
For primary bibliographic entry see Field 5G.
W89-05606

SANTA CLARA VALLEY (SILICON VALLEY), CALIFORNIA, CASE STUDY,
Sunnyvale, CA.
For primary bibliographic entry see Field 5G.
W89-05611

SOUTH BRUNSWICK, NEW JERSEY, CASE STUDY,
Wisconsin Univ.-Milwaukee. Dept. of Urban Planning.
For primary bibliographic entry see Field 5G.
W89-05612

BEDFORD, MASSACHUSETTS, CASE STUDY,
For primary bibliographic entry see Field 5G.
W89-05613

ACID DEPOSITION AND THE ACIDIFICATION OF SOILS AND WATERS,
Colorado State Univ., Fort Collins. Dept. of Agronomy.
For primary bibliographic entry see Field 5C.
W89-05746

RESEARCH ON WATER QUALITY OF RESERVOIR TAILWATERS,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
M. S. Dortch, and D. E. Hamlin.
Army Corps of Engineers Waterways Experiment Station, Vicksburg, MS. Information Exchange Bulletin, Vol. E-88-2, November 1988. 7p, 2 fig, 1 tab, 14 ref.

Descriptors: *Water pollution sources, *Selective withdrawal, *Path of pollutants, *Water quality, *Reservoir releases, *Tailwater, *Model studies, *Dissolved oxygen, Thermal stratification, Iron, Manganese, Kinetics, Reaeration, Research priorities.

Many reservoirs experience seasonal thermal stratification often accompanied by dissolved oxygen (DO) depletion in bottom waters (hypolimnion). When water is released to the downstream environment, reaeration occurs. Eventually, the water quality recovers to a more natural stream condition. The recovery distance, which depends on physical and biogeochemical factors, is often on the order of miles. To address this need, a study was conducted on poor water quality associated with deep, anoxic releases at four sites: (1) the tailwater of Lake Greeson, Little Missouri River, Arkansas; (2) tailwater of Nimrod Reservoir (Fourche La Fave River, Arkansas; (3) tailwater of Rough River Reservoir, Kentucky; and (4) Buford Dam tailwater on the Chattahoochee River, Georgia. The objectives were: to develop an improved understanding of chemical transformation in tailwaters; to provide guidance on sampling and analysis of tailwater quality; and to develop an easy-to-use PC model to predict impacts of reservoir releases on tailwater quality. Preliminary results are reported for the Greeson tailwater study only. The major process affecting DO concentrations was stream reaeration. Flow rate was shown to affect oxidation rates (e.g. for iron and manganese) so that a generalized formulation for reduced iron and manganese oxidation kinetics may need to account for the local temperature, DO concentration, pH, possible a flow-related variable, and the type of substrate in the stream. Results from the remaining field studies will be used to improve the kinetic formulations of the model.(Lantz-PTT)
W89-05747

MODELING GROUNDWATER FLOW AND POLLUTION: WITH COMPUTER PROGRAMS FOR SAMPLE CASES,
Technion - Israel Inst. of Tech., Haifa. Faculty of Civil Engineering.
For primary bibliographic entry see Field 2F.
W89-05754

ANNUAL REPORT, ANALYSIS OF ACID PRECIPITATION SAMPLES COLLECTED BY STATE AGENCIES,
Global Geochemistry Corp., Canoga Park, CA.
R. McCracken.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-124292. Price codes: A22 in paper copy, A01 in microfiche. Report No. EPA/600/9-87/029, November 1987. 495p, 3 fig, 3 tab, append.

Descriptors: *Water analysis, *Water quality data, *Water polltuion sources, *Acid rain, *Data collections, Hydrogen ion concentration, Conductivity, Fluorides, Chlorides, Nitrites, Phosphates, Bromides, Nitrates, Sulfates, Ammonium, Sodium, Potassium, Calcium, Magnesium, Pollutant identification.

The analytical results from 30 state operated wet acid deposition sites summarized. All sites submitted their samples to the same laboratory so that comparisons of data could be made from different geographic areas. The use of a central laboratory also provided cost efficiencies and improved documentation of data quality. Samples are analyzed for pH, strong acid, conductivity, fluoride, chloride, nitrate, phosphate, bromide, nitrate, sulfate, ammonium, sodium, potassium, calcium, and magnesium. The report contains maps showing the location of each site, plots of analytical data during the time period, tables of all field and analytical data, a table comparing the concentration of each analyte at the different sites, a table of precipitation weighted data for each site, plots comparing field and laboratory pH and conductivity measurements, and quality control tables and plots giving information on overall data quality. (Lantz-PTT)
W89-05759

STUDY ON TITANIUM CHLORINATION SOLID WASTES,
Krispar Technologies, Inc., Glendale, CA.
For primary bibliographic entry see Field 5D.
W89-05760

INPUT-OUTPUT MASS LOADING STUDIES OF TOXIC AND CONVENTIONAL POLLUTANTS IN TRENTON CHANNEL, DETROIT RIVER: ACTIVITIES C.1 AND F.5 IN THE UPPER GREAT LAKES CONNECTING CHANNELS STUDY (UGLCCS).
Environmental Research Lab.-Duluth, Grosse Ile, MI. Large Lakes Research Station.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-158068. Price codes: A10 in paper copy, A01 in microfiche. Report No. EPA/600/3-88/004, January 1988. 216p, 27 fig, 12 tab, 12 ref, 3 append.

Descriptors: *Water pollution sources, *Trenton Channel, *Detroit River, *Great Lakes, *Path of pollutants, Polychlorinated biphenyls, Cadmium, Channels, Nitrates, Nitrites.

Two 1986 surveys were conducted to describe concentration gradients in the Upper Great Lakes Connecting Channel Study (UGLCCS), to determine whether the channel acted as a source or a sink for the measured parameters. Intensive sampling was carried out at principal point sources discharging into the Trenton Channel and within the channel along three transects at the head and mouth of two segments during May 6-7 and August 26-27, 1986. All stations were sampled four times over the two-day surveys. To minimize error, the sampling of the channel was conducted synoptically with the point source sampling. Furthermore, sampling of the channel was timed so that it tracked the same 'plug' of water. The status of mass loadings to the Trenton Channel was ad-

dressed during the two 'snapshots' of the system. Net point source loadings of the parameters relative to loadings observed at the mouth of the Trenton Channel ranged from 0.4% (total PCB, Cycle 3, Survey II) to 41.6% (total Cd, Cycle 3, Survey II). With the exception of nitrate-nitrite (Survey III), input-output loading results suggest no major differences existed between loadings at the head of the channel vs. the mouth. Concentrations of parameters in the water were higher on the west side of the channel when compared to the east wide. (Lantz-PTT)
W89-05761

FLORIDA ACID DEPOSITION STUDY: FIVE-YEAR DATA SUMMARY.
Environmental Science and Engineering, Inc., Gainesville, FL.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-158779. Price codes: A10 in paper copy, A01 in microfiche. Report No. ESE 85-156-0106-2110, October 1987. 221p, 26 fig, 36 tab, 53 ref, append.

Descriptors: *Monitoring, *Florida, *Acid rain, *Water pollution sources, Data collections, Ecological effects, Statistical analysis, Monitoring, Chemical analysis, Air quality, Spatial distribution, Temporal distribution, Physical properties, Chemical properties, Fate of pollutants.

In November 1980, the Florida Acid Deposition Study was initiated by the Florida Electric Power Coordination Group, Inc. (FCG). The overall objective of that study was to develop and evaluate Florida-specific information on acid deposition in three major program areas: acid deposition monitoring, sources attribution and ecological effects. The Study formally ended in August 1985 with the peer review and publication of a report that synthesized data from all three program areas. Although the study made significant progress in understanding patterns of acid deposition in Florida, additional data was needed to evaluate year-to-year variability and near-term trends. Based on this conclusion, as well as the recommendations of peer reviewers, the Acid Deposition Monitoring Program was continued. Analyses were expanded to include ozone, hydrogen peroxide and nitrous acid. This Summary report presents statistical analyses of 5 years of precipitation chemistry data and 4 years of air quality data collected under the Acid Deposition Monitoring Program. Data from 7 sites in Florida were analyzed because they had been in continuous operation since the Study inception. Major conclusions are presented on spatial patterns, temporal trends, and chemical/physical relationships. (Author's abstract)
W89-05762

TRACE ORGANICS AND INORGANICS IN DISTRIBUTION AND MARKETING MUNICIPAL SLUDGES,
Los Angeles County Sanitation Districts, Whittier, CA.
For primary bibliographic entry see Field 5E.
W89-05766

GEOCHEMICAL MODELING RESEARCH RELATED TO THE SURFACE DISPOSAL OF PROCESSED OIL SHALE SOLID WASTE,
University of Wyoming Research Corp., Laramie. Western Research Inst.
For primary bibliographic entry see Field 5E.
W89-05768

DISSOLVED AND SUSPENDED MATERIAL TRANSPORTED BY THE POTOMAC RIVER AT CHAIN BRIDGE, AT WASHINGTON, D.C., WATER YEARS 1978-81,
Geological Survey, Richmond, VA. Water Resources Div.
S. F. Blanchard, and D. C. Hahl.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Supply Paper 2234-B, 1987. 43 p, 18 fig, 16 tab, 25 ref.

Descriptors: *Water quality, *Suspended sediments, *Suspended load, *Potomac River, *Potomac Estuary, Transport, Nutrients, Path of pollutants, Maryland, Virginia, District of Columbia, Phosphorus, Nitrogen, Chlorophyll.

The measuring station Potomac River at Chain Bridge at Washington, D.C., is located at the upstream end of the tidal Potomac River. Water-quality data were collected intensively at this site from December 1977 through September 1981 as part of a study of the tidal Potomac River and Estuary. Analysis of water-discharge data from the long-term gage at Little Falls, just up stream from Chain Bridge, shows that streamflow for the 1979-81 water years had characteristics similar to the 51-year average discharge (1931-81). Loads were computed for various forms of phosphorus and nitrogen, major cations and anions, silica, biochemical oxygen demand, chlorophyll alpha and pheophytin, and suspended sediment. Load duration curves for the 1979-81 water years show that 50 percent of the time, water passing Chain Bridge carried at least 28 metric tons per day of total nitrogen, 1.0 metric ton per day of total phosphorus, 70 metric tons per day of silica, and 270 metric tons per day of suspended sediment. No consistent seasonal change in constituent concentrations was observed; however, a seasonal trend in loads due to seasonal changes in runoff was noted. Some storm runoff events transported as much dissolved and suspended material as is transported during an entire low-flow year. (USGS)
W89-05773

PHYSICAL AND CHEMICAL CHARACTERISTICS OF WATER IN COAL-MINE PONDS, EASTERN OKLAHOMA, JUNE TO NOVEMBER 1977-81,
Geological Survey, Norman, OK. Water Resources Div.
L. J. Slack, and S. P. Blumer.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. Oklahoma Geological Survey Special Report 87-2, 1987. 116 p, 10 fig, 6 tab, 65 ref.

Descriptors: *Water quality, *Coal mining, *Strip mine lakes, *Water chemistry, *Oklahoma, Lakes, Chemical properties, Physical properties, Sulfates, Iron, Manganese.

At 102 sites in 59 coal-mine ponds (strip mine lakes) in eastern Oklahoma, during June to October, water in the ponds deeper than about 10 feet was stratified; temperature, dissolved oxygen, and pH usually decrease with depth. Concentrations of dissolved sulfate, chloride, iron, and manganese varied from site to site. Specific conductance, which is a general measure of dissolved solids in the water, ranged from 93 to 4,800 micromhos per centimeter at 25 degrees Celcius. Mean specific-conductance values and dissolved-sulfate concentrations were greatest in ponds associated with mining of Secor, Wier-Pittsburg, and Dawson coals and least in ponds associated with mining of the Iron Post and Hartshorne coals. Mean dissolved-iron concentrations were greatest in ponds associated with mining of the Secor, Dawson, and Hartshorne coals. Mean dissolved-manganese concentrations were greatest in ponds associated with mining of the Secor, Dawson, and Weir-Pittsburg coals. (USGS)
W89-05780

FIELD APPLICATION OF PARAMETER IDENTIFICATION IN GROUNDWATER CONTAMINANT TRANSPORT MODELING: A CASE STUDY,
Washington Univ., Seattle. Dept. of Civil Engineering.
K. J. Holmes, and W. Chu.
Available from National Technical Information Service, Springfield, VA 22161 as PB89-101901/AS, price codes: A04 in paper copy, A01 in microfich. Project completion report, June, 1987. 44 p, 23 fig, 3 tab, 23 ref. Contract 14-08-0001-G1259. Project USGS G1259-05.

Descriptors: *Groundwater pollution, *Algorithm, *Parameter identification, *Simulation model, *Path of pollutants, Groundwater, Water pollution sources, Data requirements, Model studies, Optimization, Method of characteristics, Solute transport, Transmissivity, Dispersion.

The application of a parameter identification (PI) algorithm in groundwater contaminant transport modeling is attempted in this study. The computer code used was a combination of an ordinary least square optimization routine and the United States Geological Survey's Method of Characteristics Code (USGS-MOC). In working with engineers and scientists from Washington State Department of Ecology and the consulting firm Golder and Associated, a suitable field problem with adequate monitoring data was selected. Using available observations, the transmissivity and dispersivity were calibrated by both the PI approach and the more conventional trial-and-error approach. The calibrated parameters were then used by USGS-MOC in simulation of remedial action effects. Although the PI procedure allowed a more objective and efficient search of suitable model parameters, the parameters found by the PI routine in even a well-monitored site may not be physically plausible. The determination of proper parameters by a PI method must still be determined with significant user intervention. (USGS)
W89-05781

5C. Effects Of Pollution

CONSIDERATIONS IN THE DEVELOPMENT OF A PROPOSED MONITORING AND TESTING PROGRAM TO ASSESS THE IMPACT OF SUBSURFACE WASTE INJECTION,
INTERA Technologies Ltd., Ottawa (Ontario). Hydrogeology Group.
For primary bibliographic entry see Field 7A.
W89-04585

PROCEEDINGS OF THE ENVIRONMENTAL PROBLEMS IN KARST TERRANES AND THEIR SOLUTIONS CONFERENCE.
Bowling Green, Kentucky. October 28-30, 1986. National Water Well Association, Dublin, OH. 1986. 525 p.

Descriptors: *Karst, *Environmental effects, *Geohydrology, *Geochemistry, *Geophysics, *Groundwater, *Hazardous materials, *Legal aspects, *Planning, Regional planning, Tracers, Pollutants, Conferences.

Government officials, consulting engineers, hydrogeologists, geologists, researchers, industry representatives and others participated in a conference on environmental problems in karst terranes. The following karst topics were covered: hydrology and geochemistry of carbonate karst terranes; legal aspects of karst hydrology; response to spills of hazardous materials in karst terranes; groundwater monitoring in karst terranes; sinkhole investigation and remediation; water tracing techniques; regional planning for karst terranes; and geophysical investigations of karst terranes. (See W89-04587 thru W89-04613) (Hammond-PTT)
W89-04586

U.S. ENVIRONMENTAL PROTECTION AGENCY EMERGENCY RESPONSE TO TOXIC FUMES AND CONTAMINATED GROUND WATER IN KARST TOPOGRAPHY: BOWLING GREEN, KENTUCKY,
Environmental Protection Agency, Atlanta, GA. Region IV.
For primary bibliographic entry see Field 5B.
W89-04596

LIMNOLOGICAL STUDY OF LAKE BRUIN, LOUISIANA,
Geological Survey, Baton Rouge, LA. Water Resources Div.
For primary bibliographic entry see Field 2H.
W89-04660

TYPHOID OUTBRAKE AT PARADISE MILLS PUBLIC HOUSING COMPLEX,
Environmental Protection Agency, San Juan, PR.

Caribbean Office.
R. Shelton, and J. Martinez.
IN: Third Caribbean Islands Water Resources Congress. Proceedings of a Symposium held in St. Thomas, U.S. Virgin Islands, July 22-25, 1986. p 3-6, 2 fig.

Descriptors: *Public health, *Water quality, *Typhoid, *St. Croix, *Virgin Islands, Drinking Water, Groundwater budget, Well water, Desalination, Water quality control, Potable water.

The Paradise Mills Public Housing Complex (PMPHC) consists of 14 buildings with 124 apartments which house approximately 650 persons. PMPHC is located in St. Croix on a hill where ventilation is natural. PMPHC gets its drinking water from roof catchments and from the Department of Public Works (DPW). DPW water is generally a combination of well water and desalted water which is pumped directly to the complex's 741,000 gallon cistern located at the south end of the development. The cistern has two openings on its top which were used for batch chlorination and cleaning. The water is pumped from the cistern to each building. The sewer system consists of 4-inch pipes at the top of the hill connecting into 6-inch pipes at the low end. Numerous sewer back ups had occurred, mainly from clogging with clothes, sanitary napkins and other heavy material. In June, 1984, a 14 year old boy was identified with typhoid fever from PMPHC. The boy presented symptoms of vomiting and high fever, and was hospitalized for 18 days. This was the only case identified during 1984. In June 1985 new typhoid fever cases were identified. From the 24 cases identified with typhoid or related symptoms, 16 cases consumed drinking water from the Paradise Hills Complex. Of the 24 cases, 15 ate Ice Pops prepared by a resident from PMPHC. The investigation team concluded that the Ice Pops prepared by Mrs. Pena could have been the source of the outbreak either by contamination of the Ice Pops by a carrier or the preparation of the Ice Pops with contaminated water. The quality of the water from Paradise Mills was not rated as safe to drink. The government of the Virgin Islands has implemented recommendations by EPA in an effort to eliminate any potential risk of having another typhoid outbreak in this complex. (See also W89-04665) (Lantz-PTT)
W89-04666

ECOLOGICAL FEATURES OF AN ARTIFICIAL WETLANDS AREA,
Vsesoyuznyi Nauchno-Issledovatel'skii Inst. Gidrotekhniki i Melioratsii, Kharkov (USSR).
For primary bibliographic entry see Field 5G.
W89-04701

EFFECTS OF PEATLAND FORESTRY MANAGEMENT AND FUEL PEAT MINING IN LAKE ILAJANJARVI, EAST FINLAND: A PALEOLIMNOLOGICAL STUDY,
Joensuu Univ. (Finland). Karelian Inst.
For primary bibliographic entry see Field 4C.
W89-04726

EFFECT OF ENVIRONMENTAL VARIABLES ON ENTERIC VIRUS SURVIVAL IN SURFACE FRESHWATERS,
Health Effects Research Lab., Cincinnati, OH.
For primary bibliographic entry see Field 5B.
W89-04746

SUMMARY OF THE US ARMY CORPS OF ENGINEERS/US ENVIRONMENTAL PROTECTION AGENCY FIELD VERIFICATION PROGRAM,
Battelle Ocean Sciences, Duxbury, MA.
For primary bibliographic entry see Field 5E.
W89-04854

SYNTHESIS OF RESEARCH RESULTS: APPLICABILITY AND FIELD VERIFICATION OF PREDICTIVE METHODOLOGIES FOR AQUATIC DREDGED MATERIAL DISPOSAL,
Environmental Research Lab., Narragansett, RI.
For primary bibliographic entry see Field 5E.
W89-04855

ACID DEPOSITION IN MARYLAND: THE STATUS OF KNOWLEDGE IN 1987.
Maryland Power Plant Research Program.Report No. AD-88-1, January 1988. 224p.

Descriptors: *Water pollution sources, *Acid rain, *Maryland, *Water pollution effects, State government, Monitoring, Water pollution prevention, Economic aspects.

The deposition of acidic materials, commonly termed 'acid rain,' and its potential ecological and economic effects have been vigorously discussed at the international, national, state, and local levels of government. The Maryland General Assembly passed a measure, HB-27, during its 1986 session that assigns responsibility to the Power Plant Research Program (PPRP) to coordinate and direct the efforts of the Departments of Natural Resources and Environment in evaluating and conducting research on this topic and to issue an annual report to the Governor and General Assembly pursuant to Section 3-3A-04 of the Natural Resources Article of the Code of Maryland. This report, the second submitted under this requirement, summarizes the major technical issues and scientific findings concerning the formation and potential effects of acid deposition on environmental and economic resources in Maryland. (See W89-04862 thru W89-04871) (Lantz-PTT)
W89-04861

AQUATIC RESOURCES,
A. Janicki, H. Greening, and R. Klauda.
IN: Acid Deposition in Maryland: The Status of Knowledge in 1987. Maryland Power Plant Research Program Report No. AD-88-1, January 1988. p 107-124, 2 fig, 1 tab, 59 ref.

Descriptors: *Aquatic life, *Stream biota, *Acid rain effects, *Aquatic environment, *Water pollution effects, *Maryland, *Fish, Water chemistry, Acidification, Environmental effects, Bioassay, Mortality, Toxicity, Spawning.

Surveys of surface water chemistry in Maryland have demonstrated that habitat acidification is a potentially serious threat to some aquatic resources, particulary finfish species, that use poorly buffered Coastal Plain streams as spawning sites. Understanding the effects of acidic episodes on fish populations is a difficult task that requires carefully designed and rigorously executed studies. The majority of biological evidence now available to relate habitat acidification to reduced fish survival in Maryland has been compiled by laboratory studies. However, laboratory data alone cannot prove conclusively that fish populations are indeed being adversely affected by acidic episodes. Field investigations using flow-through and instream bioassay techniques or habitat manipulation studies are required to confirm laboratory findings. A direct link between acid deposition, surface water acidification, and fish mortality has not yet been observed in Maryland streams. Published information indicates that eggs and larvae of several Bay fishes are very sensitive to acidic conditions that have been observed in some Coastal Plain streams. However, except for striped bass larvae in the Nanticoke River, field confirmation of laboratory-based toxicity predictions is lacking for those Bay fishes that appear to be most at risk from acidic episodes. Abnormally dry springs in 1985 and 1986 produced few episodes that approached acutely toxic or acid levels in Maryland study streams. Irregular or perhaps infrequent occurrences of detrimental acidic episodes are to be expected even in the most vulnerable watersheds. Therefore, the impact of acidic episodes on Bay fish populations will likely vary considerably among years, among streams, and among species. Studies aimed at confirming instream mortality from acidic conditions are continuing in Maryland. (See also W89-04861) (Lantz-PTT)
W89-04865

TERRESTRIAL RESOURCES,
G. DeMuro, M. Buncick, B. Hood, and J. C. Bernabo.
IN: Acid Deposition in Maryland: The Status of Knowledge in 1987. Maryland Power Plant Research Program Report No. AD-88-1, January 1988. p 125-138, 1 fig, 3 tab, 26 ref.

Descriptors: *Crop production, *Water pollution effects, *Air pollution effects, *Acid rain, *Environmental effects, *Maryland, Agriculture, Cropland, Forests, Ozone.

Numerous potential impacts of acid deposition on agricultural crops have been identified in greenhouse, laboratory and research studies under simulated conditions more acidic than average Maryland rainfall. However, there is not direct evidence to indicate that ambient acid deposition is harmful to Maryland crops. The potential indirect and direct effects of acid rain on crops were reported for the various crops and cultivars of similar crops under various simulated rainfall conditions in last year's report. The primary direct effect of acid deposition on crops is the leaching of organic compounds and inorganic nutrients from plant tissues. Indirect effects of acid deposition include increased susceptibility to diseases; however, improved growth following exposure to acidic deposition has been reported. Indirect effects of acid rain on crops through soil influences are considered negligible on managed land. Crop damage from exposure to ozone at levels known to occur in Maryland has been reported on soybeans. New research On ozone may allow the impacts of acid deposition on crops, either alone or in combination with other stress factors (e.g., ozone) to be more clearly identified. Forest decline in Maryland has not been attributed to acid deposition. (See also W89-04861) (Lantz-PTT)
W89-04866

HEALTH AND PHYSICAL RESOURCES,
W. Jaeschke, and K. Symms.
IN: Acid Deposition in Maryland: The Status of Knowledge in 1987. Maryland Power Plant Research Program Report No. AD-88-1, January 1988. p 139-144. 19 ref.

Descriptors: *Air pollution effects, *Environmental effects, *Public health, *Acid rain, *Maryland, Air pollution, Respiration, Damage.

Recent results from the ongoing Harvard Six City Studies and related research suggest that relationships exist between acidic airborne pollutants (not necessarily acid rain) and increased respiratory symptoms. However, complexities in measuring exposure and dose-response relationships make it difficult to quantify cause and effect. At present, no direct evidence exists linking current levels of acid deposition to human health effects in any population. Additional study is continuing on this subject. The significance of these new developments for the health of Maryland residents exposed to acid deposition should be closely evaluated. No significant new information on acid-deposition-related damage to materials and structures is available. New studies have been proposed to quantify 'damage functions'.(See also W89-04861) (Lantz-PTT)
W89-04867

INTEGRATED APPROACH TO A STUDY OF CONTAMINANTS AND TOXICITY IN MONROE HARBOR (RIVER RAISIN), MICHIGAN, A GREAT LAKES AREA OF CONCERN: SUMMARY REPORT.
Environmental Research Lab.-Duluth, Grosse Ile, MI. Large Lakes Research Station.
For primary bibliographic entry see Field 5A.
W89-04877

TOTAL EXPOSURE AND RISK ASSESSMENT FOR DRINKING WATER CONTAMINATED WITH VOLATILE ORGANIC COMPOUNDS,
Illinois Univ. at the Medical Center, Chicago. School of Public Health.
J. M. Clark, and C. L. Fuller.
Available from the National Technical Information

Service, Springfield, VA 22161, as PB88-160502. Price codes: A06 in paper copy, A01 in microfiche. Report No. ILENR/RE-AQ-87/22, December 1987. 119 p, 42 tab, 97 ref, append. Illinois Department of Energy and Natural Resources Contract AQ 11.

Descriptors: *Water treatment, *Drinking water, *Volatile organic compounds, *Water pollution effects, *Water quality control, Public health, Organic compounds, Risk assessment, Fate of pollutants.

A total exposure and cancer risk assessment was conducted on nine volatile organic compounds (VOCs) frequently found in contaminated drinking water. Routes of exposure considered in the analysis included ingestion, inhalation and dermal uptake. A total of ten exposure scenarios were constructed, reflecting minimum and maximum likelihood exposures. The total exposure scenarios developed for VOCs, the most extensive reported to date, clearly supports the need to consider non-ingestion exposure routes in the development of drinking water standards for VOCs. Recent maximum contaminant levels (MCLs) developed by USEPA for six of the VOCs evaluated appear not to have been derived considering the non-ingestion exposure routes. Moreover, as the new MCLs result in cancer risks of 0.000001 to 0.001, using the exposure relationships developed in this study, they may be insufficiently protective of public health. As inhalation and possibly dermal exposure routes may be more significant than the ingestion route, regulatory agencies should determine the risks before permitting drinking waters, significantly contaminated with VOCs, to be used for bathing or cooking for long time periods prior to obtaining an alternative water supply or implementing other corrective measures. (Lantz-PTT)
W89-04884

SUBLETHAL PHYSIOLOGICAL EFFECTS OF PULP AND PAPER MILL EFFLUENTS ON FISH: A LITERATURE REVIEW,
National Swedish Environment Protection Board, Solna.
T. Andersson.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-157540. Price codes: E04 in paper copy, A01 in microfiche. September 1987. 50p, 1 tab.

Descriptors: *Literature review, *Fish physiology, *Pulp and paper industry, *Water pollution effects, *Toxicity, Bibliographies, Hydrocarbons, Chlorine, Bleaching wastes.

Pulp and paper mill effluents have been shown to disturb several fundamental physiological functions such as respiration and the oxygen transport capacity of the blood, metabolic functions as well as growth and reproduction. Neural lesions and histological changes in several organs and mutagenic effects have also been reported. In recent years, attention has been directed toward toxic effects of effluents from pulp bleaching processes. The possible sublethal effects of chlorinated hydrocarbons and other by-products of the chlorine-bleaching processes would seem to be important from environmental and public health perspectives. Considerable effort has been expanded over the past 15 years to determine the nature of fish responses to pulp and paper mill effluents. In this review the sublethal toxic responses of fish to pulp and paper mill effluents are described. The review contains 76 papers and is intended to cover literature published during the period 1973-1986. A small number of earlier papers considered of interest are also included. (Lantz-PTT)
W89-04896

RECONNAISSANCE INVESTIGATION OF WATER QUALITY, BOTTOM SEDIMENT, AND BIOTA ASSOCIATED WITH IRRIGATION DRAINAGE IN THE KENDRICK RECLAMATION PROJECT AREA, WYOMING, 1986-87,
Geological Survey, Cheyenne, WY. Water Resources Div.
D. A. Peterson, W. E. Jones, and A. G. Morton.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 87-4255, 1988. 57p, 6 fig, 17 tab.

Descriptors: *Drainage effects, *Water quality, *Wyoming, Stream biota, Irrigation programs, Water sampling, Surface water, Trace elements, Radioisotopes, Pesticides, Selenium, Groundwater, Water quality standards, Drinking water, North Platte River, Bottom sediments, Land reclamation, Pollutant identification.

A reconnaissance investigation of the Kendrick Reclamation Project in central Wyoming was conducted during 1986-87 to determine if irrigation drainage has caused or has the potential to cause harmful effects on human health, fish, and wildlife, or other water uses. The investigation of the Kendrick Reclamation Project is one of nine similar investigations being conducted in the western conterminous United States as part of the Department of the Interior's Irrigation Drainage Program. Samples of surface water were collected at 10 sites and ground water at 5 sites. Surface-water analyses included trace elements, radiochemicals, and pesticides. Concentrations in the water generally were less than national standards for public water supplies, with the exception of selenium. The median concentration of dissolved selenium was 7.5 microgm/L in 24 samples of surface and groundwater. Of the 11 samples that contained dissolved-selenium concentrations greater than the national standard for public water supplies of 10 microgm/L, 10 of the samples were collected at sites on streams that are not used for public water supplies; the eleventh sample was collected from a shallow well. Dissolved-selenium concentrations ranged from less than 1 to 300 microgm/L. Concentrations of dissolved selenium in the North Platte River, which supplies drinking water for several municipalities, ranged from less than 1 to 4 microgm/L. The dissolved-selenium concentration and selenium discharge in the North Platte River increased in the downstream direction. The four principal tributaries that receive drainage from the Kendrick Reclamation Project contributed substantially to the increase in selenium concentration and discharge in the North Platte River. Bottom-sediment samples from the North Platte River contained selenium contents of 1.2 microgm/g or less. (Author's abstract)
W89-04899

LONG-TERM WATER-QUALITY CHARACTERISTICS OF CHARLOTTE HARBOR, FLORIDA,
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 5B.
W89-04950

COMPARISON OF MUSSELS AND CRUSTACEAN PLANKTON TO MONITOR HEAVY METAL POLLUTION,
Balatoni Limnologiai Kutato Intezete, Tihany (Hungary).
For primary bibliographic entry see Field 5A.
W89-04972

MIDWEST (U.S.A.) RESERVOIR WATER QUALITY MODIFICATION: I. PARTICULATE PARAMETERS,
Iowa Dept. of Natural Resources, Des Moines.
V. I. Okereke, E. R. Baumann, T. A. Austin, and D. S. Lutz.
Water, Air, and Soil Pollution WAPLAC, Vol. 37, No. 3-4 p 309-324, February 1988. 3 fig, 4 tab, 25 ref.

Descriptors: *Water quality, *Water quality control, *Low-flow augmentation, *Nonpoint pollution sources, *Particulate matter, *Reservoirs, Water sampling, Dam effects, Iowa, Flood-control storage, Suspended solids, Phosphates, Annual runoff.

Both qualitative and quantitative approaches were used to evaluate the impact of a flood control, low flow augmentation reservoir on suspended solids and total phosphate (particulate parameters). Fourteen years of weekly sampling data above, in and downstream of the reservoir both before and after the reservoir became operational were analyzed. The effects of the reservoir on the particulate parameters are considered. There was a dramatic increase in both suspended solids and total phosphate concentrations in the reservoir discharges, particularly during periods of high river flows and high reservoir inflow parameter concentrations. At all sampling stations, the annual parameter loading rate (kg per ha per year) correlated with annual runoff (cm per year). The suspended solids removal efficiency of the reservoir was dependent on annual runoff and averaged about 90%. Non-point source contributions of suspended solids were well over 99% when annual runoff exceeded 6.57 cm per year and over 95% even when annual runoff was as low as 1.63 cm per year. (See W89-04975 thru W89-04976) (Author's abstract)
W89-04974

CONCENTRATIONS OF TRACE ELEMENTS IN YELLOW PERCH (PERCA FLAVESCENS) FROM SIX ACIDIC LAKES,
Rutgers - The State Univ., New Brunswick, NJ. Center for Coastal and Environmental Studies.
M. D. Sprenger, A. W. McIntosh, and S. Hoenig.
Water, Air, and Soil Pollution WAPLAC, Vol. 37, No. 3-4 p 375-388, February 1988. 4 fig, 5 tab, 22 ref.

Descriptors: *Water pollution effects, *Path of pollutants, *Lakes, *Trace elements, *Perch, *Acidic water, Muscle, Mercury, Cadmium, Lead, Zinc, Liver, Heavy metals, New Jersey, Tissue analysis.

Yellow perch (Perca flavescens) were collected from six small acidic lakes in northwestern New Jersey. Analyses of muscle tissue identified a pattern of increased concentrations of Hg in fish from the most acidic lakes; levels of Cd and Pb were greatly elevated in livers of specimens from two of the most acidic lakes. At one site, Sunfish Pond, positive correlation between fish size and Hg levels in muscle and Cd concentrations in livers were detected. In only one case did Hg concentrations in muscle tissue exceed FDA action level of 1 microg per g (wet wt). In some respects, patterns of trace element accumulation were expected. Mercury accumulation in muscle tissue was highest in specimens taken from highly acidic Crater Lake and Long Pine Pond. Also, relatively little Cd and Pb was detected in muscle tissues of any specimens; Zn concentrations were relatively consistent in all study systems, except Lake Success. Some findings were unanticipated, however. The exceedingly high Pb concentrations in liver tissues of specimens from Crater Lake and Long Pine Pond may indicate that, under highly acidic conditions in certain lakes, Pb activity may increase greatly and that the liver may be a significant site of storage. In general, the results support the conclusion that enhanced activity of such trace elements as Hg and Pb in acidic lakes may be expected. (Miller-PTT)
W89-04977

FACTS AND FALLACIES CONCERNING MERCURY UPTAKE BY FISH IN ACID STRESSED LAKES,
Toronto Univ. (Ontario). Inst. for Environmental Studies.
L. A. Richman, C. D. Wren, and P. M. Stokes.
Water, Air, and Soil Pollution WAPLAC, Vol. 37, No. 3-4 p 465-473, February 1988. 75 ref.

Descriptors: *Water pollution sources, *Water pollution effects, *Path of pollutants, *Lakes, *Mercury, *Fish, *Acidic water, *Absorption, *Acid rain effects, Hydrogen ion concentration, Methylation, Food chain, Biomagnification.

Some of the mechanisms proposed to account for elevated mercury levels in biota from acid-stressed lakes are reviewed. The first hypothesis suggests that higher concentrations of Hg may be entering the watershed with acidic deposition than non-acidic deposition because of the long range transport of Hg from combustion sources. The second

hypothesis states that higher concentrations of Hg are present in the water column of acid stressed lakes compared with circumneutral or alkaline lakes because the acidic conditions result in the mobilization of sediment bound Hg. Futhermore, Hg bound to soil in the surrounding watershed could be mobilized by acidic deposition and could enter the lake as runoff. The third hypothesis describes a pH effect on Hg speciation. Inorganic Hg is methylated both chemically and biologically to produce mono and dimethyl Hg. The pH and chloride concentrations in the water will influence the formation of methyl Hg chloride or hydroxide compounds. The fourth hypothesis addresses the effect that acidification has on the microorganisms which methylate and demethylate the Hg in the sediment and water column. Rather than altering the end product of methylation, acidic conditions can alter the rate of Hg methylation and/or demethylation by microorganisms. The fifth hypothesis suggests that the biotic characteristics of an acidic lake rather than the H(+) can influence the Hg concentrations in fish. For example, the productivity and standing stock of biomass in acidic or acidifying lakes is lower than that in eutrophic lakes. The final hypothesis concerns the direct effects of acidification on the biota. Rather than proposing that absolute levels of Hg are changing in the aquatic system, it is hypothesized that the biota in acidifying lakes are more efficient bioaccumulators of methyl Hg and/or are unable to excrete Hg at a rate comparable to that in more neutral conditions. It is a fallacy to suggest that one mechanism can fully explain the various differences in Hg uptake and accumulation in fish among lakes reported in the literature. Therefore, it is a fact that Hg cycling and uptake in natural lakes is governed by an array of interlocking and sometimes co-varying factors. (Miller-PTT)
W89-04982

CHRYSOPHYTE SCALES IN LAKE SEDIMENTS PROVIDE EVIDENCE OF RECENT ACIDIFICATION IN TWO QUEBEC (CANADA) LAKES,
Trent Univ., Peterborough (Ontario). Trent Aquatic Research Centre.
S. S. Dixit, A. S. Dixit, and R. D. Evans.
Water, Air, and Soil Pollution WAPLAC, Vol. 38, No. 1-2, p 97-104, March 1988. 3 fig, 1 tab, 34 ref.

Descriptors: *Water pollution effects, *Acid rain effects, *Acidification, *Acid rain, *Acidic lakes, *Lake sediments, *Sediments, *Canada, *Chrysophyta, Hydrogen ion concentration, Fate of pollutants, Acid rain, Acidic lakes, Acidic water, Quebec.

Chrysophycean algal microfossils were analyzed from the sediments of Lake Bonneville and Lake Truit Rouge in Quebec. The chrysophyte flora in the study lakes was stable until 40 years ago, but since then the taxa characteristic of acidic or slightly acidic waters increased in abundance. The study provides evidence of recent lake acidification in Quebec and supports existing speculations that lakes in the Quebec region are highly sensitive to and are probably being affected by the increase in acidic precipitation. Although pH decline in only two lakes is documented, it is likely that long-term deposition of strong acids may have caused a shift in pH in many other soft-water lakes in Quebec. In poorly buffered regions of Quebec, lake acidification is likely to accelerate if present acid deposition patterns continue. (Miller-PTT)
W89-04988

ACCUMULATION OF HG AND CR BY THREE AQUATIC SPECIES AND SUBSEQUENT CHANGES IN SEVERAL PHYSIOLOGICAL AND BIOCHEMICAL PLANT PARAMETERS,
Darjeeling Government Coll. (India). Dept. of Botany.
For primary bibliographic entry see Field 5B.
W89-04989

EFFECT OF HEAVY METALS ON GROWTH POPULATION OF A FECAL COLIFORM BACTERIUM ESCHERICHIA COLI IN AQUATIC ENVIRONMENT,
Darjeeling Government Coll. (India). Dept. of Botany.
S. Jana, and D. N. Bhattacharya.
Water, Air, and Soil Pollution WAPLAC, Vol. 38, No. 3-4, p 251-254, April 1988. 1 tab, 11 ref.

Descriptors: *Water pollution effects, *Escherichia coli, *Aquatic environment, *Heavy metals, *Population dynamics, Coliforms, Cadmium, Lead, Copper, Arsenic, Mercury, Chromium.

The data on the effects of the concentrations (0.5, 1, 2, 5 mg/L) of the heavy metals Hg, As, Pb, Cu, Cd, and Cr on changes in growth population of a fecal coliform bacterium Escherichia coli (in terms of number of E. coli per 100 ml of water) showed a gradual decline in growth population of the fecal coliform bacterium with the increase of exposure time, as well as concentration of the metals over control data. The effects were markedly recorded with the treatment of 5 mg/L. In general, the harmful effects of the metals on growth population of E. coli were found by the treatments in the order: Cd > Pb > Cu > As > Hg > Cr. (Author's abstract)
W89-04993

CHEMISTRY OF PRECIPITATION NEAR A LIMESTONE BUILDING,
Antwerp Univ., Wilrijk (Belgium). Dept. of Chemistry.
For primary bibliographic entry see Field 5B.
W89-04996

PHYSIOLOGY OF PHYTOPLANKTON IN RELATION TO METAL CONCENTRATION: EFFECT OF CADMIUM ON SCENEDESMUS BIJUGATUS AND NITZSCHIA PALEA,
Cochin Univ. (India). School of Environmental Studies.
K. S. Sathya, and K. P. Balakrishnan.
Water, Air, and Soil Pollution WAPLAC, Vol. 38, No. 3-4, p 283-297, April 1988. 9 fig, 3 tab, 33 ref.

Descriptors: *Water pollution effects, *Cadmium, *Physiological ecology, *Phytoplankton, Sublethal effects, Absorption, Biomass, Proteins, Lipids, Carbohydrates, Productivity, Respiration, Path of pollutants.

The effect of Cd at sublethal concentrations on pure cultures of S. bijugatus and N. palea was studied with special reference to their physiology during exponential growth phase. Photosynthetic productivity, respiration, pH, biomass, pigments, carbohydrate, protein, lipid as well as nutrient uptake were selected to study the comprehensive effect of the metal. It was shown exposure of test species to Cd in 10 to 50 microg/L range caused physiological disturbances such as variation in rates of net production rate and respiration; levels of carbohydrates, proteins and lipids and pigments; growth rate; and biomass. It may also be noted that N. palea was more sensitive to Cd in the range 20 to 40 microg/L where the increase in net production and pH of the culture was not reflected in the increase in carbohydrate, protein or lipid. The loss of photosynthetic carbon, therefore, merits detailed investigation. Significant variations in the rates of net production, respiration and pigment levels suggest that these parameters cannot be relied upon to draw realistic conclusions in metal toxicity studies. The computation of primary production based on pigment levels may also be more misleading than realistic as these two parameters cannot be correlated in metal toxicity studies without a comprehensive study of all the parameters. The physiological responses of the species to Cd stress were comparable to the effect of nutrient and light limitation in altering the ratio of macromolecules such as pigments, carbohydrates, proteins, and lipids. Such alterations may render the algal species unsuitable for secondary production, which will upset the trophic levels in the ecosystem. (Miller-PTT)
W89-04997

DIAZINON TOXICITY EFFECT ON PROTEIN AND NUCLEIC ACID METABOLISM IN THE LIVER OF ZEBRAFISH, BRACHYDANIO RERIO (CYPRINIDAE),
Gorakhpur Univ. (India). Dept. of Zoology.
B. A. Ansari, and K. Kumar.
Science of the Total Environment STENDL, Vol. 76, No. 1, p 63-68, September 15 1988. 4 tab, 19 ref.

Descriptors: *Pesticides, *Water pollution effects, *Toxicity, *Fish, *Diazinon,Proteins, Metabolism, Amino acids, Acetylcholine, Nucleic acids, Zebrafish.

Four-month old adult siblings of zebrafish were exposed to four concentrations of diazinon for up to 168 h. Deoxyribonucleic acid, ribonucleic acid, protein and total free acid content were monitored in the liver. There were significant changes in the nucleic acid protein and total free amino acid contents in the liver of diazinon-exposed zebrafish. The increased deoxyribonucleic acid content during the initial stages of exposure suggests that the tissue first attempted to repair the damage caused by diazinon. It is concluded that diazinon not only inhibits acetylcholine, but it also disturbs the basic cell constituents of fish. (Miller-PTT)
W89-05011

ACUTE TOXICITY OF CRESOLS, XYLENOLS, AND TRIMETHYLPHENOLS TO DAPHNIA MAGNA STRAUS 1820,
Institut Pasteur de Lyon (France).
J. Devillers.
Science of the Total Environment STENDL, Vol. 76, No. 1, p 79-83, September 15 1988. 1 tab, 18 ref.

Descriptors: *Water pollution, *Water pollution effects, *Toxicity, *Daphnia, *Phenols, *Cresols, *Xylenols, *Trimethylphenols.

Twenty-four hour IC50 values (50% immobilization concentration) for phenol, o-cresol, m-cresol, p-cresol, six xylenols, and three trimethylphenols were determined for Daphnia magna under static conditions. Results show that cresols are more toxic than phenol, that xylenols do not exhibit significantly higher toxicity than cresols, and that trimethylphenols are less toxic than cresols. Thus, no direct relationship can be found between the number and position of methyl groups on the phenol nucleus and their acute toxicity to the water flea. (Author's abstract)
W89-05013

TRIBUTYLTIN CONTAMINATION IN THE FIRTH OF FORTH (1975-87),
Napier Coll. of Commerce and Technology, Edinburgh (Scotland).
S. K. Bailey, and I. M. Davies.
Science of the Total Environment STENDL, Vol. 76, No. 2/3, p 185-192, October 15 1988. 3 fig, 1 tab, 12 ref. Department of the Environment Contract PECD 7/8/80.

Descriptors: *Water pollution sources, *Water pollution effects, *Path of pollutants, *Pesticides, *Boating, *Firth of Forth, *Scotland, *Tributyltin, Dogwhelks, Coastal waters, Harbors.

Contamination of the Firth of Forth (Scotland) by tributyltin compounds leached from antifouling paints has been identified using the degree of penis development (imposex) in the common dogwhelk Nucella lapillus. In 1987, a high degree of imposex was observed in the vicinity of pleasure craft activity, fishing harbors and a boat yard, reflecting localized inputs of tributyltin from these sources. Dogwhelks collected in 1975 from sites comparable to those surveyed in 1987 showed lower degrees of imposex and also a lower incidence of penis development in females. (Author's abstract)
W89-05016

MERCURY-RESISTANT BACTERIA IN THE SEDIMENT OF MINAMATA BAY,
National Inst. for Minamata Disease, Minamata (Japan). Dept. of Basic Medical Science.
K. Nakamura, T. Fujisaki, and Y. Shibata.
Nippon Suisan Gakkaishi NSVGAF, Vol. 54, No. 8, p 1359-1363, August 1988. 4 fig, 1 tab, 20 ref.

Descriptors: *Marine bacteria, *Mercury compounds, *Water pollution, *Minamata Bay, *Japan, *Marine sediments, Mercury chloride, Methylmercury chloride, Phenylmercuric acetate, Pseudomonas, Bacillus, Corynebacterium.

The occurrences of Hg-resistant bacteria in relation to mercury chloride, methylmercury chloride and phenylmercuric acetate was examined, using various strains isolated from the Minamata Bay, as well as from control sediments with low levels of Hg. Minimal inhibitory concentrations (MICs) to mercury chloride were significantly higher for the Pseudomonas sp. ($p<0.01$, Mentel-Cox test) and Bacillus sp. ($p<0.05$) from the Bay sediments than for those from the control sediments. The MICs to methylmercury chloride were likewise higher for the Bacillus sp. ($p<0.01$) from the Bay sediments, and so were the MICs to phenylmercuric acetate for the Pseudomonas sp. ($p<0.001$) from the Bay sediments than for those from the control sediments. The percentage of highly Hg-resistant bacteria belonging to various genera increased with the concentration of Hg in the sediments. Hg-sensitive Pseudomonas, Bacillus and Corynebacterium sp. were also observed in the Minamata Bay sediments. (Author's abstract)
W89-05031

EFFECTS OF ACID-IRON WASTES ON ESTUARINE ORGANISMS: RECENT FIELD AND LABORATORY EXPERIMENTS,
Laboratoire Municipal d'Hygiene, Le Havre (France).
F. Proniewski, and P. Lassus.
Marine Biology MBIOAJ, Vol. 96, No. 3, p 451-457, November 1987. 7 fig, 3 tab, 30 ref.

Descriptors: *Estuaries, *Zooplankton, *Phytoplankton, *Fish, *Industrial wastewater, *Water pollution effects, *Toxicity, *Acidic water, Hydrogen ion concentration, Mortality, Seine Estuary, France.

Several experiments were made in 1982 and 1983 to evaluate the effects of acid-iron waste from a French titanium dioxide plant on marine fauna. Experiments were carried out in the plume area of the Seine Estuary and in the laboratory to determine the effects of pH on mortality rates. Field results, on in situ phytoplankton and stickelback (Gasterosteus aculeatus) and brown shrimp (Crangon crangon) from haul catches in the Seine and Loire estuaries, revealed no effect of short-term exposure (10 s) to pH 3 and the laboratory bioassays failed to reveal any deleterious effects on two diatoms, Chaetoceros septentrionale and Phaeodactylum tricornutum, the flagellate, Dunaliella tertiolecta, the copepod, Trigriopus brevicornus as well as G. aculeatus, of exposure to pH 3 for 30 or 90 s. (Author's abstract)
W89-05034

PETROLEUM HYDROCARBONS IN THE MARINE BIVALVE VENUS VERRUCOSA: ACCUMULATION AND CELLULAR RESPONSES,
Malta Univ., Msida. Dept. of Mathematics and Science.
V. Axiak, J. J. George, and M. N. Moore.
Marine Biology MBIOAJ, Vol. 97, No. 2, p 225-230, February, 1988. 4 fig, 2 tab, 22 ref.

Descriptors: *Oil pollution, *Water pollution effects, *Petroleum hydrocarbons, *Toxicity, *Mollusks, Malta, Mediterranean Sea, Metabolic fate.

Cellular and subcellular responses of the marine burrowing bivalve Venus verrucosa collected from the northeastern coastline of Malta from January to June 1985 after exposure to petroleum hydrocarbons (PHC) were investigated. After long-term exposure to 100 microg/L of water-accomodated fractions of crude oil, PHC were found to accumulate most rapidly in the digestive gland and then in the gills, with saturation levels being reached within 100 d of exposure in both cases. PHC accumulation, both in the mantle and muscle tissues, was more gradual and consistent throughout the whole exposure period. After 150 d of exposure, the digestive cells of the digestive gland were significantly reduced in height (atrophy) and exhibited reduced lysosomal membrane stability. After 144 h of exposure to higher concentration of PHC (820 and 420 microg/L), several cytological effects were recorded, including an increase in cell volume and activity of gill mucocytes as well as in the number of haemocytes in gill blood sinuses. There was also evidence of damage to the epithelial lining of the foot, stomach and style sac and marked atrophy of the digestive cells of the digestive gland. The significance of such responses is discussed. (Author's abstract)
W89-05035

EFFECTS OF ALUMINUM AND ACID ON THE GILL MORPHOLOGY IN RAINBOW TROUT, SALMO GAIRDNERI,
Department of Fisheries and Oceans, Winnipeg (Manitoba). Freshwater Inst.
R. E. Evans, S. B. Brown, and T. J. Hara.
Environmental Biology of Fishes EBFID3, Vol. 22, No. 4, p 299-311, August 1988. 4 fig, 2 tab, 60 ref.

Descriptors: *Acid rain, *Fish physiology, *Aluminum, *Toxicity, *Acidic water, Hydrogen ion concentration, Water pollution effects, Trout.

The effects of acid and Al in acidified hard and soft water on the histology and morphometry of rainbow trout gills were studied to determine relevant toxicity indicators within the gill tissue. Acid and Al promoted measurable primary epithelial hyperplasia which proved to be a reliable biological indicator of acid and Al contamination and possibly of some predictive value. Low levels of Al and acid resulted in hypertrophied chloride cells, suggesting a role in adapting to the contaminants. High concentrations of Al (>10 micromol/L) caused chloride cell necrosis and consequently a decline in cell numbers over time. Al precipitates accumulating within the chloride cell cytoplasm probably lead to impaired function prior to cell degeneration. The morphological alterations resulted in a decrease in water space between secondary lamellae (up to 40% within 14 d) which may reduce the efficiency of gas exchange. Twice the Al was required in hard water to elicit a similar soft water tissue response. Pathological changes were more severe with Al at pH 5.2 than at pH 4.7; results of Al speciation suggest that both labile and non-labile fractions are responsible for the induction of gill lesions. Low levels of Al may protect fish from the effects of high hydrogen ion concentration. (Author's abstract)
W89-05036

EFFECT OF HEATED EFFLUENT ON THE OCCURRENCE AND THE REPRODUCTION OF THE FRESHWATER LIMPETS ANCYLUS FLUVIATILIS MULLER, 1774, FERRISSIA WAUTIERI (MIROLLI, 1960) AND ACROLOXUS LACUSTRIS (L., 1758) IN TWO DUTCH WATER BODIES,
Keuring van Electrotechnische Materialen N.V., Arnhem (Netherlands).
R. H. Hadderingh, G. van der Velde, and P. G. Schnabel.
Hydrobiological Bulletin HYBUD9, Vol. 21, No. 2, p 193-205, December 1987. 7 fig, 2 tab, 13 ref.

Descriptors: *Gastropods, *Limpets, *Thermal pollution, *Cooling water, *Heated water, Powerplants, Reproduction, Life cycles, Ancylus fluviatilis, Ferrissia wautieri, Acroloxus lacustris, The Netherlands.

The discharge of cooling water favors the occurrence of freshwater limpets. Reproduction of A. fluviatilis is stimulated by the higher temperature of the cooling water; the life cycle of F. wautieri (nearly exclusively found in the outlet areas) does not, however, differ from that under natural temperature regimes. For A. lacustris this is not clear as detailed studies on the life cycle under natural temperature circumstances are lacking. A. lacustris and F. wautieri could be found in large numbers on hard substrates (stones), as well as on plant material in sheltered as well as in exposed situations. In this respect they differ from A. fluviatilis, which is restricted in its occurrence to hard substrates and exposed situations. It is not clear whether the occurrence of A. fluviatilis is also influenced by some form of competition for food by Bithynia tentaculata; both feed on diatoms. Further experimental studies of this question should yield interesting results. The changes in numbers of the three freshwater limpet species are mainly due to reproduction and migration, both largely governed by temperature and day length. It was possible to reconstruct the influence of cooling water in the Bergumermeer area by means of the ratio between the numbers of A. lacustris and F. wautieri. The share of Ferrissia was highest near the outlet and decreased with the distance from this station. (Author's abstract)
W89-05042

EFFECTS OF STORMWATER SEWER DISCHARGES ON THE AQUATIC COMMUNITY IN URBAN CANALS IN LELYSTAD,
C. Roos, and E.J.B. Uunk.
Hydrobiological Bulletin HYBUD9, Vol. 21, No. 2, p 207-212, December 1987. 2 tab, 13 ref.

Descriptors: *Urban runoff, *Storm water, *Storm runoff, *Sewer systems, *Canals, *Water quality, *Algae, *Diatoms, *Hydrophytes, *Macroinvertebrates, The Netherlands.

In urban areas with a separate sewerage system, the stormwater runoff is discharged into surface waters. A study on the effects of stormwater sewer discharges on the composition of the aquatic community in urban waters was carried out in two areas with a primarily residential use in the new town of Lelystad. The aquatic organisms considered included hydrophytes, epiphytic diatoms, filamentous algae and macroinvertebrates. The stormwater sewer discharges cause a slight change in the composition of the aquatic community. The water in the urban surface waters can be haracterized as eutrophic and beta- to alpha-mesosaprobic. Near stormwater sewer outfalls the water tends to the more polluted alpha-mesosaprobic state. The shifts in the composition of the aquatic community could be traced primarily on the basis of a number of epiphytic diatoms and macroinvertebrates (in particular some Diptera and Trichoptera). Most hydrophytes, filamentous algae and the remaining epiphytic diatoms and macroinvertebrates (in particular water beetles and water mites) turned out to be of little or no use in this respect. Because the investigation was carried out in an unusually dry summer, the results probably underestimate the effects of stormwater discharges on the aquatic community. (Author's abstract)
W89-05043

NUMERICAL WATER ASSESSMENT OF RIVERS IN HOKURIKU DISTRICT USING EPILITHIC DIATOM ASSEMBLAGE ON RIVER BED AS A BIOLOGICAL INDICATOR: 1. THE VALUES OF DIATOM ASSEMBLAGE INDEX TO ORGANIC WATER POLLUTION (DAI PO),
For primary bibliographic entry see Field 5A.
W89-05071

EFFECTS OF TEMPERATURE ON MICROBIAL UTILIZATION OF LIGNOCELLULOSIC DETRITUS IN A THERMALLY IMPACTED SYSTEM,
Texas Univ. at Austin, Port Aransas. Marine Science Inst.
R. Benner, and J. V. McArthur.
Microbial Ecology MCBEBU, Vol. 16, No. 3, p 323-330, 1988. 1 fig, 2 tab, 15 ref. DOE contract DE-AC09-76SROO-819.

Descriptors: *Temperature effects, *Thermal water, *Thermophilic bacteria, *Nuclear powerplants, Plant tissues, Microbiological studies, Effluents, Mineralization, Adaptation, South Carolina.

The effects of temperature on rates of mineralization of C-14-lignocellulose were investigated in water and sediment from a thermally impacted stream and from a nearby unimpacted swamp at the Savannah River Plant, South Carolina. The

temperature optimum for lignocellulose mineralization remained near 35 C at the unimpacted site throughout the sampling period from November 1986 to May 1987. The temperature optimum for lignocellulose mineralization in the thermally impacted stream was near 45 C when thermal effluents from a nuclear reactor were released to the stream, and was near 35 C when the reactor was not operating. Microbial populations capable of rapidly degrading lignocellulose at higher temperatures (45-55 C) developed between 9 and 27 days under conditions of thermal stress, indicating that under favorable conditions thermophilic microorganisms became dominant components of the microbiota. Removal of thermal stress for periods of 75 days or less resulted in a collapse of the thermophilic degrading population. (Author's abstract)
W89-05081

ZOOBENTHIC DISTRIBUTION AND BIOMASS IN THE TURKEY LAKES,
Department of Fisheries and Oceans, Burlington (Ontario). Great Lakes Lab. for Fisheries and Aquatic Sciences.
For primary bibliographic entry see Field 2H.
W89-05093

FISH COMMUNITY STRUCTURE, BIOMASS, AND PRODUCTION IN THE TURKEY LAKES WATERSHED, ONTARIO,
Great Lakes Forestry Research Centre, Sault Sainte Marie (Ontario).
J. R. M. Kelso.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 45, Suppl. 1, p 115-120, 1988. 2 fig, 5 tab, 21 ref.

Descriptors: *Acid rain effects, *Lake acidification, *Canada, *Fish populations, *Aquatic productivity, *Lake basins, *Ecological effects, Headwaters, Biomass, Water depth, Alkaline water, Phytoplankton, Assimilative capacity, Organic carbon, Comparison studies, Streams, Ontario.

The Turkey Lakes Watershed in Ontario contains four lakes, and the headwater lake (Batchawana Lake) consists of two distinct basins, neither of which supports a native, reproducing fish stock. Fish biomass varied by a factor of 3.3 among the other three lakes in the watershed. Fish flesh production varied by a factor of only 1.5 in the system. Salmonid and small cyprinid contribution to biomass and production increased with progression downstream. Both fish biomass and production per unit surface area decreased with increasing lake depth. The fish biomass and production in the watershed was strongly influenced by depth, but alkalinity and phytoplankton carbon assimilation also were related to stock and production. Wishart Lake, immediately below Batchawana Lake, has a fish stock with restricted recruitment, and cyprinids make only a limited contribution to the observed production. Although both these conditions may be symptomatic of lake acidification, it is unclear whether the situation in this watershed results from lake acidification or biogeographic factors. (See W89-05082 thru W89-05093 and W89-05095 thru W89-05101) (Authors abstract)
W89-05094

YOUNG-OF-THE-YEAR FISH COMMUNITY IN NINE LAKES, VARYING IN PH, ON THE CANADIAN SHIELD,
Great Lakes Forestry Research Centre, Sault Sainte Marie (Ontario).
J. R. M. Kelso, and J. H. Lipsit.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 45, Suppl. 1, p 121-126, 1988. 4 fig, 3 tab, 22 ref.

Descriptors: *Acid rain effects, *Water pollution effects, *Bioindicators, *Canada, *Fish populations, *Sensitivity analysis, *Hydrogen ion concentration, *Lakes, Spawning, Species diversity, Air pollution effects, Seasonal variation, Aquatic environments, Comparison studies, Alkaline water, Ontario, Canadian Shield.

In nine Canadian Shield lakes, seven with resident fish populations, the young-of-the-year (yoy) were first captured some 4 weeks and more following the major spring depressions in pH. Since spawning of many resident species followed the spring freshet, yellow perch (Perca flavescens), darters, and many cyprinids sensitive to low pH would hatch and develop following the most serious spring changes in chemistry. Within a lake, the period of peak abundance occurred within a period of 2-9 wk during the 3 yr study. Abundance of yoy was not strongly linked to lake pH or alkalinity. Diversity of yoy was strongly related to lake pH ($r=0.87$) and alkalinity ($r=0.89$). Monitoring the larval fish community appears to provide a responsive, reproducible measure of change for some of the fish communities sensitive to effects of acidic deposition and can be carried out with only moderate expenditure of time and resources. (See W89-05082 thru W89-05094 and W89-05096 thru W89-05101) (Authors abstract)
W89-05095

RISK TO SALMONIDS OF WATER QUALITY IN THE TURKEY LAKES WATERSHED AS DETERMINED BY BIOASSAY,
Lake Superior Research Station, Sault Sainte Marie (Ontario).
W. Kwain, and J. R. M. Kelso.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 45, Suppl. 1, p 127-135, 1988. 3 fig, 6 tab, 16 ref.

Descriptors: *Acid rain effects, *Bioassay, *Toxicity, *Canada, *Water pollution effects, *Fish populations, *Lakes, Watersheds, Headwaters, In situ tests, Trout, Trace metals, Statistical analysis, Ions, Hydrogen ion concentrations, Ontario.

Batchawana Lake, the headwater lake in the Turkey Lakes Watershed, was devoid of fish. Although as number of factors could cause this fishless state, in situ studies were conducted to partially address conditions related to lake acidification. The spring pH depression did not induce significant, consistent mortality to rainbow trout (Salmo gairdneri) or lake trout (Salvelinus namaycush) caged in situ. In 1981, however, considerable mortality occurred to fish caged in Batchawana Lake during or immediately following the maximum spring pH depression. In the remaining lakes, mortality occurred later in the exposure period. Whole-body concentrations of Na(+), Ca(++), and Mg(++) in rainbow trout caged (1980) in three lakes were similar; however K(+) appeared slightly higher (but not statistically different) in fish held in the headwater lake. Static bioassays indicated that the 96-hour pH-LC50 for brook trout (Salvelinus fontinalis) was 3.80-4.09, considerably lower than the lowest pH, 4.66, observed during spring. Brook trout corralled in Batchawana Lake grew slightly faster and accumulated more Pb and Hg than fish held in a downstream lake. Although pH and trace metal levels in Batchawana Lake may at times be inhospitable to fish, other factors likely contributed to the fishless condition of this lake. (See W89-05082 thru W89-05095 and W89-05097 thru W89-05101) (Author's abstract)
W89-05096

FOSSIL MIDGE ASSOCIATIONS IN RELATION TO TROPHIC AND ACIDIC STATE OF THE TURKEY LAKES,
Department of Fisheries and Oceans, Owen Sound (Ontario). Great Lakes Fisheries Research Branch.
M. G. Johnson, and O. C. McNeil.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 45, Suppl. 1, p 136-144, 1988. 5 fig, 2 tab, 31 ref.

Descriptors: *Acid rain effects, *Lake sediments, *Canada, *Fossils, *Water pollution effects, *Midges, *Aquatic productivity, Sensitivity analysis, Trophic level, Species diversity, Cores, Species composition, Phosphorus, Deposition, Variability, Ontario.

Most changes in profiles of relativ: abundance of Chironomus, Sergentia, Procladius, Heterotrissocladius, Micropsectra, Tanytarsus, and other taxa in dated sediment cores suggested a trend to more oligotrophic conditions at present in four dimictic lakes (Upper and Lower Batchawana Lakes, Little Turkey Lake and Turkey Lake in Ontario), but not in the single polymictic lake in which species composition was least variable temporally. Decreased numbers of chironomids and chaoborids toward the present indicated declining productivity in all five lakes. Total phosphorus concentrations in sediments declined through these periods of inferred greater oligotrophy. Most of these trends were probably not caused by anthropogenic acidification because they began up to 130 years B.P. and they were sometimes duplicated even deeper in sediment cores. Furthermore, taxa common in acidified lakes elsewhere did not increase in these lakes. Recent acidification may have affected taxonomic composition and diversity of chironomids in the headwater lake, the only lake which showed a near-surface reduction in members of the tribe Tanytarsini, and the ratio of taxa to individuals. Chaoborus americanus occurred at high densities throughout the cores from the upper two lakes, indicating that these two lakes probably never had fish communities. (See W89-05082 thru W89-05096 and W89-05096 thru W89-05101) (Author's abstract)
W89-05097

EFFECT OF ACID PRECIPITATION ON MICROBIAL DECOMPOSITION PROCESSES IN SEDIMENT FROM STREAMS IN THE TURKEY LAKES WATERSHED,
Guelph Univ. (Ontario). Dept. of Environmental Biology.
M. J. Jensen, N. K. Kaushik, P. T. S. Wong, and J. B. Robinson.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 45, Suppl. 1, p 159-169, 1988. 7 fig, 3 tab, 36 ref.

Descriptors: *Acid rain effects, *Water pollution effects, *Canada, *Microbial degradation, *Sediments, *Streams, *Simulation analysis, Decomposing organic matter, Settleable solids, Suspended sediments, Glucose, Plant tissues, Sensitivity analysis, Watersheds, Sulfates, Nitrates, Hydrogen ion concentration, Ontario.

The effect of simulated acid precipitation (pHs between 3.5 and 5.9) on the breakdown of organic matter in streams was examined under laboratory conditions using two different sediment types from streams. Decomposition processes were measured using C14-labelled glucose, leaf leachate, and leached leaf material. The data indicated that penetration of acid into settled sediment is small. Therefore, little effect of pH on organic matter breakdown could be perceived. During suspended conditions, however, a marked decrease in breakdown rates was noted. It appeared that under these conditions a slight stimulation in decomposition rates caused by the sulfate and nitrate present in the acid precipitation occurred. The effect of pH on the rate of organic matter breakdown depended on the type of substrate used in the experiment. Glucose decomposition was least inhibited by pH, followed by leaf leachate, and leached leaf material breakdown was the most inhibited. Sediment with higher organic matter was more sensitive under conditions of suspension, but less sensitive than the sediment with less organic matter under settled conditions. This appeared to be a result of the lower penetration of acid in the settled organic sediment. (See W89-05082 thru W89-05099 and W89-05101) (Author's abstract)
W89-05100

BLOOD OXYGEN CAPACITY DIFFERENCES IN YELLOW PERCH (PERCA FLAVESCENS) FROM NORTHERN WISCONSIN LAKES DIFFERING IN PH,
Wisconsin Univ.-Madison. Center for Limnology.
J. A. Nelson, J. J. Magnuson, and W. Chulakasem.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 45, No. 10, p 1699-1704, October 1988. 2 fig, 2 tab, 27 ref.

Descriptors: *Wisconsin, *Water pollution effects, *Acid rain effects, *Fish diseases, *Lakes, *Oxygen requirements, *Acidic water, Adaptation, Perch, Hydrogen ion concentration.

Whether chronic exposure to environmental acidity reduces oxygen loading in fish is still uncertain. This question is evaluated by looking for evidence of adaptations to hypoxia in a population of yellow perch (Perca flavescens) isolated in a well-oxygenated, naturally acidic lake. Perch were sampled directly from this naturally acidic lake (pH 4.5) and two circumneutral lakes, one of which experiences low oxygen. Fish were bled rapidly via cardiac puncture. Hemoglobin, hematocrit, and erythrocyte number were determined by standard methods. Hemoglobin concentrations were highest in perch from the acid lake (6.4 grams/deciliter), intermediate in the neutral lake with anoxic zones (5.7 grams/deciliter) and lowest in the well-oxygenated neutral lake (4.8 grams/deciliter). Increased hemoglobin per red cell accounted for this trend. Slightly larger hematocrits in acid lake perch (41.2 versus 36.2) were achieved through small increases in red cell number and volume. Evidence suggests that these results are part of an adaptational response different from the hematological responses of fish to acute acid exposure. (Author's abstract)
W89-05102

VALIDITY OF AN ECOTOXICOLOGICAL TEST SYSTEM: SHORT-TERM AND LONG-TERM EFFECTS OF ARSENATE ON MARINE PERIPHYTON COMMUNITIES IN LABORATORY SYSTEMS,
Goeteborg Univ. (Sweden). Dept. of Botany.
For primary bibliographic entry see Field 5A.
W89-05105

INDUCED COMMUNITY TOLERANCE IN MARINE PERIPHYTON ESTABLISHED UNDER ARSENATE STRESS,
Goeteborg Univ. (Sweden). Dept. of Botany.
For primary bibliographic entry see Field 5A.
W89-05106

LAKES. 7. SUCCESSION: SEASONAL SUCCESSION OF PHYTOPLANKTON SIZE ASSEMBLAGES AND ITS ECOLOGICAL IMPLICATIONS IN THE NORTH AMERICAN GREAT LAKES,
Canada Centre for Inland Waters, Burlington (Ontario).
M. Munawar, I. F. Munawar, and L. H. McCarthy.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IVTLAP, Vol. 23, No. 2, p 659-671, August 1988, 3 tab, 5 fig, 27 ref.

Descriptors: *Acid rain effects, *Water pollution effects, *Limnology, *Lakes, *Phytoplankton, *Great Lakes, Lake Superior, North Channel, Georgian Bay, Lake Ontario, Cyanophyta, Chrysophyceae, Diatomeae, Cryptophyceae, Algae, Metals, Nitrogen, Phosphorus, Photosynthesis, Statistical analysis, Toxicity.

The overwhelming dominance of nannoplankton in the phytoplankton biomass and overall community structure has been demonstrated in all of the North American Great Lakes. Three oligotrophic ecosystems were studied: Lake Superior, the North Channel and Georgian Bay, and a mesoeutrophic/eutrophic environment, Lake Ontario. Seasonal succession of size assemblages demonstrated that the dominance of the minute organisms bore no relationship to trophic status. Although ultraplankton and other size assemblages were prevalent in all the ecosystems, their chlorphyll/biomass and production/biomass quotients differed suggesting that various nutrient, contaminant, and physical variables characteristic of each lake may be responsible for the observed gradient of photosynthetic efficiency. The Lake Superior case study indicated that the lake remained oligotrophic with low nutrients but possessed the highest photosynthetic efficiency. Seasonality of various size fractions was related to species and indicated that species belonging to Cyanophyta (Cyanobacteria), Chrysophyceae, Diatomeae, and Cryptophyceae played a role in lake dynamics. Statistical evaluation of the data did not show any significant correlation between biotic and abiotic factors. Various size fractions, particularly ultraplankton, were very sensitive to contaminants such as metal mixtures, and the addition of nutrients did not ameliorate the observed toxicity. Light experiments with surface and deep-residing algae suggest that light was a limiting factor especially during long periods of deep mixing. (Author's abstract)
W89-05159

ACIDIC LAKE LAKEENJARVI, EASTERN FINLAND: PHYTOPLANKTON SUCCESSION AND WATER CHEMISTRY,
Maj and Tor Nessling Foundation, Helsinki (Finland).
For primary bibliographic entry see Field 2H.
W89-05163

LONG-TERM DYNAMICS OF PLANKTON COMMUNITIES IN LAGO MAGGIORE (N. ITALY),
Istituto Italiano di Idrobiologia, Pallanza (Italy).
For primary bibliographic entry see Field 5G.
W89-05166

DIURNAL CHANGES OF DIC AND DO BY PHYTOPLANKTON COMMUNITY DURING CONTINUOUS ACIDIFICATION IN EXPERIMENTAL PONDS,
National Inst. for Environmental Studies, Tsukuba (Japan). Div. of Chemistry and Physics.
T. Kawai, K. Miyamoto, K. Aoyama, Y. Umezawa, and A. Otsuki.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IVTLAP, Vol. 23, No. 2, p 764-769. August 1988, 6 fig, 1 tab, 9 ref.

Descriptors: *Acid rain effects, *Water pollution effects, *Limnology, *Acidic water, *Hydrogen ion concentration, *Carbon, *Phytoplankton, Ponds, Dissolved oxygen, Chlorophyll a, Alkalinity, Water temperature, Diurnal fluctuations, Experimental data.

The initial change of water acidification is not only a decrease in pH but also a decrease in alkalinity and dissolved inorganic carbon (DIC) which supports photosynthetic carbon metabolism. The dissolved form of DIC also changes. The real time response of a little controlled phytoplankton community was observed during the course of artificial acidification of the pond water with respect to changes in DIC and pH. Measurements were carried out in the outdoor experimental ponds at the Kasumigaura Water Research Station of the National Institute for Environmental Studies in Japan. The main species in the ponds were: Chlamydomonas sp., Oocystis borgei, Tetraedron minimum, Actinastrum hantzschii, and Coelastrum reticulatum. During the first two days, DIC did not decrease, even though pH began decreasing immediately. DIC decreased little by little. While acid was added into the experimental pond continuously at a constant rate, pH fell and CO2 gas in the water was supersaturated. Concentration of CO2 soon reached a steady state which lasted until akalinity decreased to zero. Diurnal fluctuation of dissolved oxygen (DO) was observed continuously throughout the acidification experiment. It is concluded that DIC change is not only a good index of photosynthetic and respiratory activity but also an important environmental factor during the acidification of water. (Davis-PTT)
W89-05169

INTERNAL NITROGEN AND PHOSPHORUS LOADS IN LAKE ROTORUA, NEW ZEALAND,
Ministry of Works and Development, Hamilton (New Zealand). Water Quality Centre.
J. C. Rutherford.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IVTLAP, Vol. 23, No. 2, p 828-831, August 1988. 3 fig, 7 ref.

Descriptors: *Limnology, *Water pollution effects, *Water pollution sources, *New Zealand, *Eutrophic lakes, *Municipal wastewater, *Pollution load, Lake Rotorua, Hypolimnion, Phosphorus, Nitrogen, Deoxygenation rate, Lake sediments, Stratification.

Lake Rotorua is a large, shallow, eutrophic lake which has important recreational and Maori cultural values. Of the catchment, 30% is unmodified and 70% is pastoral farmland, exotic forest, or urban area. Treated sewage effluent from Rotorua City (population 60,000) is discharged into the lake. There has been a deterioration of lake water quality associated with an increased sewage nutrient load. Lake Rotorua is polymictic and stratifies intermittently during November to March, typically for 3 to 10 days. During stratification, hypolimnion oxygen depletion and nutrient release from the sediments occur. Using a nonsteady model together with monthly monitoring data, estimates of internal phosphorus and nitrogen loads were made for the period 1972 to 1986. Although the precision of these estimates is only plus or minus 25%, a relationship is apparent between internal and external nutrient loads in this lake, notably for nitrogen. It is suggested that this relationship reflects an increase in lake deoxygenation rate (also related to external load) which has caused more frequent and/or longer periods of both phosphorus and nitrogen regeneration from the sediments. (Davis-PTT)
W89-05177

COMPARISON OF P, CA AND MG CONTENTS OF PHYTOPLANKTON BETWEEN THE HEADS OF TWO RIVER RESERVOIRS WITH DIFFERENT PHOSPHORUS LOADING,
Ehime Univ., Matsuyama (Japan). Dept. of Environment Conservation.
H. Kagawa, M. Togashi, and Z. Kawabata.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IVTLAP, Vol. 23, No. 2, p 1022-1027, August 1988. 4 fig, 1 tab, 11 ref.

Descriptors: *Limnology, *Water pollution effects, *Red tide, *Reservoirs, *Phytoplankton, *Phosphorus, *Eutrophication, *Chlorophyll a, *Nutrients, Ishitegawa Dam, Japan, Calcium, Magnesium, Nomura Dam, Seston.

At the head of a river reservoir, the Ishitegawa Dam Reservoir in Japan, blooms of phytoplankton such as a freshwater red tide occurred frequently under a continuous feeding of phosphorus, by the inflowing river water. Phosphorus, calcium, and magnesium contents of phytoplankton were compared between the heads of two reservoirs, the Ishitegawa Dam and the Nomura Dam Reservoirs. The water temperatures at the heads of the two reservoirs were almost the same and varied seasonally between 4.1 C and 30.3 C. Chlorophyll a concentrations at the heads also changed seasonally, high in the summer and low in the winter. In the Ishitegawa Dam, significant negative correlations were found between the chlorophyll a concentration and the elemental content of seston in common with three elements, but in the Nomura Dam, no such negative correlations were found. The decrease in the magnesium contents of seston along with the increase in chlorophyll a concentration in the Ishitegawa Dam may be one of the results of the changes in the nitrogen metabolism of phytoplankton under phosphorus limitation, because the chlorophyll a contents of seston became lower than those in the Nomura Dam along with the increase in chlorophyll a concentration. Although the flow rates of the two inflowing rivers varied widely, the nitrate - nitrogen concentrations of these waters were enough to remain at fairly high levels in the lake waters. The differences in the phosphorus loadings between the two reservoirs became wider than those between the two inflowing river waters because of the low flow rate of the Ishite River. These differences, however, seem to have no effects on the growth of phytoplankton. (Davis-PTT)
W89-05190

AGRICULTURAL DEVELOPMENT AND EUTROPHICATION OF LAKE MAHINERANGI, NEW ZEALAND,
Otago Univ., Dunedin (New Zealand). Dept. of

Zoology.
T. J. Malthus, and S. F. Mitchell.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IVTLAP, Vol. 23, No. 2, p 1028-1031, August 1988. 1 tab, 18 ref.

Descriptors: *Limnology, *Water pollution effects, *Cultivated lands, *Eutrophic lakes, *Phytoplankton, *Agricultural runoff, *Phosphorus, *Fertilizers, New Zealand, Seaonal variation, Daphnia, Lake Mahinerangi, Reservoirs, South Island, Nitrogen.

Agriculture is considered to be the greatest threat to New Zealand's inland water quality. Usually, only phosphorus fertilizers are applied; clovers are sown to enhance soil nitrogen fixation. Rates of phosphorus fertilizer application are among the heaviest in the world. Lake Mahinerangi, a soft water, polymictic hydroelectric reservoir in South Island, has provided an opportunity to study the long term effects of agricultural development in the absence of other human influence such as sewage or industrial wastes. Since the lake was first studied in 1963-65, the catchment basin, originally unmodified native grassland, has been progressively developed for agriculture. As land development has proceeded, phytoplankton productivity has increased. Some changes in phytoplankton species composition indicate eutrophication. The only significant long term change in the crustacean zooplankton has been an increase in the abundance of the largest species, Daphnia carinata. The changes in phytoplankton production and species composition, oxygen and dissolved reactive phosphorus provide clear indication that Lake Mahinerangi has become more eutrophic. Average concentrations of total pigment have increased by less than 50%. Seasonal variations in chlorophyll a are related largely to variations in large algae, which have relatively little effect on the transparency or vertical attenuation of light. Concentrations of both total nitrogen and total phosphorus in drainage from the catchments generally increased with increasing amounts of agricultural development. The results suggest that the impact of agriculture on inorganic nitrogen concentrations is unlikely to be any greater in the lakes with metamorphic substrata which typify much of South Island. (Davis-PTT)
W89-05191

USE OF LONG-TERM ECOLOGICAL DATA AND SEQUENTIAL DECISION PLANS IN MONITORING THE IMPACT OF GEOTHERMAL ENERGY DEVELOPMENT ON BENTHIC MACROINVERTEBRATES,
California Univ., Berkeley. Div. of Entomology and Parasitology.
V. H. Resh, J. K. Jackson, and E. P. McElravy.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IVTLAP, Vol. 23, No. 2, p 1142-1146, August 1988. 1 fig, 1 tab, 14 ref.

Descriptors: *Geothermal power, *Geothermal energy, *Thermal pollution, *Water pollution effects, *Environmental impact statement, San Francisco, California, Caddisflies, Ecosystems, Benthos, Temperature effects, The Geysers.

The largest geothermal power project in the world is located at The Geysers, approximately 100 km north of San Francisco, California. The geothermal power plants produce enough electricity for 1.8 million California homes. Geothermal effluents can adversely affect aquatic organisms. From 1976 to 1983, the ecological effects of geothermal energy development on stream biota were examined at The Geysers. The monitoring program would be conducted as follows: seven sample units would be collected at the site; sample units would be sorted and Hydropsyche spp. counted sequentially; cumulative density would be plotted on the sequential decision plan until either the impacted or unimpacted decision line is cross. Impact is defined as a 25% or greater reduction of species richness. Predictions are made using seven years of benthic samples as baseline data. Examination of temporal change is the approach used in monitoring programs that lack unimpacted reference sites for comparison with potentially impacted sites. Successful use of this approach requires separation of natural variability from changes caused by perturbations. At The Geysers, there were significant relationships between various biotic parameters and annual precipitation patterns. The use of long term data sets for making predictions requires that the dependent variable be associated with some independent variable, or that the system be stable over time. Regulatory agencies, industries, ecological consultants, and the concerned public can be involved in predetermining levels that must be maintained during the assessment period. (Davis-PTT)
W89-05201

PRIMARY PRODUCTION IN A SMALL AGRICULTURAL STREAM,
Iowa State Univ., Ames. Dept. of Animal Ecology.
R. W. Bachmann, K. J. Kortge, and T. E. Robertson.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IV TLAP, Vol. 23, No. 2, p 1179-1182, August 1988. 2 tab, 21 ref.

Descriptors: *Solar radiation, *Water pollution effects, *Phosphorus, *Nitrogen, *Agricultural watersheds, *Dissolved oxygen content, *Primary productivity, Big Creek, Iowa, Corn, Soybeans, Respiration, Oxygen saturation, Agricultural runoff, Tile drainage, Diurnal distribution.

The primary production and community respiration in an agricultural stream was measured and the way this type of stream fits into the river continuum concept was determined. The study was conducted in June through October in 1982 and 1983 on Big Creek, a small stream in Boone County, IO. The stream originates as a combination of groundwater seepage and the flow of drainage tiles that provide subsurface drainage from surrounding fields used to grown corn and soybeans. A total of 73 diurnal curves were obtained in 1982 and 61 in 1983. Significant diurnal variations were found for dissolved oxygen with average daily highs of 121% of saturation and average daily lows of 59% of saturation. The low values were not expected for a shallow, open stream with no sources of municipal or industrial pollution. The rate of gross primary production for Big Creek was highly variable from day to day. The rates of primary production and community respiration were high relative to other streams that have been studied. The high rate of production is not surprising in view of the nutrient rich status of surface waters in this part of the country and the open nature of this stream. No detectable changes in dissolved oxygen concentration were found in the light or dark bottles of stream water that were incubated from 4 to 6 hours in the summer of 1982. The combination of high nutrient inputs from an agricultural watershed with a scarcity of trees to shade the water surface results in a stream with a high rate of primary production. At the same time allochthonous inputs of dissolved organic matter from the watershed result in community metabolism that is twice as large as could be supported by production within the stream itself. (Davis-PTT)
W89-05205

TRACE ELEMENT CONTENT IN DRINKING WATER OF NASOPHARYNGEAL CARCINOMA PATIENTS,
Hunan Medical Coll., Changsha (China). Dept. of Environmental Medicine.
X. Ling-Wei, L. Shao-Xian, J. Ji-Wen, Z. Xiao-Juan, and L. Jian.
Trace Elements in Medicine, Vol. 5, No. 3, p 93-96, 3rd quarter, 1988. 4 tab, 16 ref.

Descriptors: *Trace metals, *Heavy metals, *Drinking water, *Carcinogens, *Nickel, *Human diseases, *China, Morbidity, Hydrogen ion concentration, Trace elements.

Residents of the Xiangxi region of Hunan province in China show a high incidence of nasopharyngeal carcinoma (NPC). To analyze the relation between NPC and trace elements, the concentrations of seven trace elements in drinking water from high- and low-incidence areas were studied (75 samples). The results showed that the concentrations of Ni, Zn and Cd in drinking water from the high-incidence area were significantly higher than those in the low-incidence area. Especially, the Ni level in drinking water had a significant positive correlation with NPC morbidity. These observations are consistent with earlier studies. A highly positive correlation between Ni/pH value in drinking water and NPC morbidity also was found. This suggested that considering the ion concentration alone was not sufficient; one should also pay attention to the pH of the drinking water when studying the relationship between NPC and trace elements. Because pH in the medium can strongly affect trace element chemical characteristics and its metabolic state in living systems, the M/pH (M = metal concentration) ratio may be a considerably important factor, worthy of further research. (Author's abstract)
W89-05253

DISTRIBUTION OF THREE NYMPHAEID MACROPHYTES (NYMPHAEA ALBA L., NUPHAR LUTEA (L.) SM. AND NYMPHOIDES PELTATA (GMEL.) O. KUNTZE) IN RELATION TO ALKALINITY AND UPTAKE OF INORGANIC CARBON,
Katholieke Univ. Nijmegen (Netherlands). Lab. of Aquatic Ecology.
A. J. M. Smits, M. J. G. De Lyon, G. Van der Velde, P. L. M. Steentjes, and J. G. M. Roelofs.
Aquatic Botany AQBODS, Vol. 32, No. 1-2, p 45-62, October 1988. 4 fig, 4 tab, 49 ref, append.

Descriptors: *Acid rain, *Distribution patterns, *Macrophytes, *The Netherlands, *Aquatic plants, Plant populations, Alkalinity, Metabolism, Carbon, Statistical analysis, Data collections, Bicarbonates.

The increase in acid precipitation has led to acidification of a great number of poorly-buffered waters in The Netherlands. Nymphaea alba and Nuphar lutea are still present in these acidified waters. The production of floating leaves and the successful vegetative propagation of nymphalids may explain the survival of these macrophytes in acid waters. (Vernooy-PTT)
W89-05256

ISOETID-ZOOBENTHOS ASSOCIATIONS IN ACID-SENSITIVE LAKES IN ONTARIO, CANADA,
Toronto Univ. (Ontario). Inst. for Environmental Studies.
R. L. France, and P. M. Stokes.
Aquatic Botany AQBODS, Vol. 32, No. 1-2, p 99-114, October 1988. 4 fig, 4 tab, 61 ref.

Descriptors: *Macrophytes, *Epiphytes, *Invertebrates, *Benthos, *Oligotrophic lakes, *Acidic water, *Acid rain effects, *Water pollution effects, Littoral zone, Canada, Population density, Amphipods, Aquatic productivity.

The macrophyte and associated epiphytic invertebrate community were quantitatively sampled within the littoral zones of 28 oligotrophic lakes in south-central Ontario. Densities for 7 of 10 benthic taxa were significantly greater within Eriocaulon septangulare With. dominated mats compared with clusters of Lobelia dortmanna L. overlying sand beach. The microdistribution and abundance of amphipods was dependent on, and significantly correlated with, isoetid biomass. The depth distribution of littoral invertebrates was also closely associated with the attenuation of macrophyte biomass. Estimates of mean annual biomass ranged from 91.5 to 475.3 g dry wt/sq m for Eriocaulon, and from 44.9 to 192.1 g dry wt/sq m for Lobelia. Biomass showed no trend in relation to lake pH within the range 5.6-6.7, nor to total phosphorus in water from 5 to 14 mg/cu m. The previously-documented decrease in abundance of several littoral zoobenthic species in conjunction with lowered pH in Haliburton-Muskoka, Ontario lakes, seems explainable by direct H(+) toxicity in support of laboratory work, rather than through any second-

ary effect ascribed to disappearance of habitable substrate. (Author's abstract)
W89-05257

EFFECT OF SEWAGE TREATMENT PLANT EFFLUENTS ON THE DISTRIBUTION OF AQUATIC HYPHOMYCETES IN THE RIVER ERMS, SCHWABISCHE ALB, F.R.G.,
New Mexico State Univ., Las Cruces. Dept. of Biology.
K. Suberkropp, A. Michelis, H.-J. Lorch, and J. C. G. Ottow.
Aquatic Botany AQBODS, Vol. 32, No. 1-2, p 141-153, October 1988. 5 fig, 2 tab, 23 ref.

Descriptors: *Water pollution effects, *Bioindicators, *Wastewater pollution, *Aquatic fungi, *Stream pollution, *Fungi, *Effluents, Spatial distribution, Population exposure, Water pollution effects, Species composition, West Germany, Erms River, Biochemical oxygen demand, Phosphates, Organic matter, Bacteria, Coliforms, Ammonia.

The objective of this study was to examine the effect of sewage treatment plant effluents on the occurrence and distribution of aquatic hyphomycetes in the River Erms, a hardwater stream that originates in the Schwabische Alb (F.R.G.). Physico-chemical and bacteriological analyses of the water were performed at five sites along the stream to assess the degree of pollution. The community structure of aquatic hyphomycetes were examined up- and downstream from the input of a large sewage treatment plant by determining: 1) the total concentrations and species composition of spores filtered from the water; 2) the species composition of fungi on alder (Alnus glutinosa L.) leaves randomly collected from the stream; 3) the species composition of the fungi colonizing alder and oak (Quercus robur L.) leaf baits that were placed in the stream for 1-4 weeks. Total numbers and species composition of spores in the water were similar at sites immediately above and below the sewage plant inputs. The communities of fungi found on leaves colonized downstream from the sewage effluents were similar to those colonizing leaves at the site immediately upstream from the input, even though the downstream site exhibited considerably more pollution (judged from the higher concentrations of total organic matter, biochemical oxygen demand, phosphate, ammonia, total bacteria and coliforms). In the Erms, the community structure of aquatic hyphomycetes was not affected by effluents from the sewage treatment plant indicating that these fungi are, in all likelihood, inappropriate bioindicators of this type of pollution. (Author's abstract)
W89-05259

GROWTH OF PERCH, PERCA FLUVIATILIS L., IN RECENTLY ACIDIFIED LAKES OF SOUTHERN FINLAND - A COMPARISON WITH UNAFFECTED WATERS,
Helsinki Univ., Lammi (Finland). Lammi Biological Station.
M. Rask, and J. Raitaniemi.
Archiv fuer Hydrobiologie AHYBA4, Vol. 112, No. 3, p 387-397, May 1988. 4 fig, 4 tab, 54 ref.

Descriptors: *Acid rain effects, *Growth kinetics, *Perch, *Acidic water, *Lakes, *Fish populations, *Water pollution effects, *Fish physiology, Population exposure, Comparison studies, Aquatic animals, Food chains, Biological properties.

Growth rates of perch in four recently acidified lakes were high, with mean lengths of the 4+ age group being > 20 cm. These growth rates were better than those from non-acidified waters of both favorable and unfavorable conditions for perch growth. Differences between acidified and unaffected waters were most striking in the fish's early years. It is proposed that increased growth rates were due to the decreased competition for food among fish in acidified waters, which resulted from reduced perch populations. (Author's abstract)
W89-05284

CADMIUM TOXICITY TO GONADS IN A FRESHWATER FISH, LABEO BATA (HAMILTON),
Central Inst. of Freshwater Aquaculture, Bhubaneswar (India).
R. C. Das.
Archiv fuer Hydrobiologie AHYBA4, Vol. 112, No. 3, p 467-474, May 1988. 4 fig, 2 tab, 30 ref.

Descriptors: *Sublethal effects, *Toxicity, *Water pollution effects, *Fish populations, Population exposure, Dose-response relationships, *Cadmium, Fish physiology, Mortality, Morbidity, Fertility.

The nature of sublethal effects of cadmium on reproduction of an important Indian freshwater food fish Labeo bata is reported. The animals were exposed to an environment containing various concentrations of cadmium chloride before the onset of breeding season. Fish of both sexes underwent a significant reduction of gonosomatic index at cadmium concentrations of 4 - 10 mg/L. The testes of the treated fish were in a state of disruption and the germinal epithelia were mostly ruptured. Deleterious changes were recorded in the postmeiotic germ cells. In the ovary, the follicular developments were mostly arrested in oocyte-I and II stages and ovarian atresia and crumpling of larger oocytes were evident. Higher concentrations of cadmium salt, beyond 10 mg/L, were fatal to the fish life. The acute toxicity range of cadmium in this fish was observed to be 2.8-10.5 mg/L. Gonadal development is not much affected at lower concentrations of cadmium. (Author's abstract)
W89-05287

JOINT EFFECTS OF FOUR POLLUTANTS (COPPER, CHROMIUM, OIL, OIL DISPERSANT) ON THE RESPIRATION OF ARTEMIA,
Athens Univ. (Greece). Zoological Lab. and Museum.
G. Verriopoulos, E. Milliou, and M. Moraitou-Apostolopoulou.
Archiv fuer Hydrobiologie AHYBA4, Vol. 112, No. 3, p 475-480, May 1988. 1 fig, 1 tab, 9 ref.

Descriptors: *Water pollution effects, *Population exposure, *Toxicity, *Copper, *Chromium, *Oil, *Dispersants, *Artemia, Shrimp, Dose-response relationships, Morbidity, Respiration, Sublethal effects, Aquatic populations.

The effects of four toxicants (Cu in the form of CuSO4-(5)H2O; Cr in the form of Na2CrO4; an oil: Tunesian crude oil zarzaitine type and an oil dispersant: Finasol OSR2) and their combinations (all mixtures of two, three and four toxicants) on the respiration of Artemia was studied. The toxicant concentration tested was in all cases the LC50 48 hr (concentration of a toxicant that kills 50% of the test organism after 48 hr of exposure). All toxicant solutions caused an important and statistically significant increase on the respiration rate of the exposed animals. Furthermore, the exposure of Artemia to all types of mixtures of toxicants caused higher respiratory intensities than the exposure to the individual toxicants, although all toxic solutions tested are equitoxic as far as the survival of Artemia is concerned (the LC50 48 hr values). A linear relationship between the respiratory intensities of Artemia resulting from exposure to the toxic mixtures, and the additive indices of these mixtures (calculated in a previous paper from the effects of these mixtures on the survival of Artemia) was noticed. From this data, it becomes obvious that the interaction of pollutants, when they are acting jointly, depends also on the effect considered. (Author's abstract)
W89-05288

IMPACT OF NUTRIENT INPUT FROM THE RIVER SEINE ON PHYTOPLANKTON POPULATIONS IN A SAND-PIT LAKE (BIGNAN, NW FRANCE),
Ecole Normale Superieure, Paris (France). Lab. d'Ecologie.
J. Garnier, and B. Montesanto.
Archiv fuer Hydrobiologie AHYBA4, Vol. 112, No. 4, p 517-531, June 1988. 4 fig, 2 tab, 43 ref.

Descriptors: *Sandpits, *Rivers, *Eutrophication, *France, *Phytoplankton, *Population dynamics, *Cycling nutrients, Biomass, Primary productivity, Seasonal variation, Seine River, Diatoms, Dinoflagellates, Eutrophic lakes, Nutrients, Eutrophication, Stratification, Phosphorus, Groundwater.

Phytoplankton periodicity, biomass, primary production and environmental factors have been investigated in a shallow eutrophic sand-pit lake over two field seasons (1982-1983). Phytoplankton communities consisted mainly of small sized Chlorococcalean algae, but Cyanophycae formed undesirable blooms in summer or late summer. A typical progression from small, fast-growing species to large Dinoflagellates or diatoms, frequently observed in eutrophic stratified lakes, did not occur because of permanent nutrient replenishment, characteristic of shallow waters. High algal standing crop and primary production as well as the appearance of cyanophycae was related to important phosphorus inputs from the river Seine and to internal loading that accelerated eutrophication processes in shallow water bodies. Cyanophyceae decline appeared to be controlled by breakdown of stratification caused by wind. (Author's abstract)
W89-05291

CHRONIC ARSENIC TOXICITY FROM DRINKING TUBEWELL WATER IN RURAL WEST BENGAL,
All-India Inst. of Hygiene and Public Health, Calcutta.
D. N. Guha Mazumder, A. K. Chakraborty, A. Ghose, J. D. Gupta, and D. P. Chakraborty.
Bulletin of the World Health Organization BWHOA6, Vol. 66, No. 4, p 499-506, 1988. 3 fig, 3 tab, 21 ref.

Descriptors: *Well water, *Arsenic, *Toxicity, *Water pollution effects, *Drinking water, *Human pathology, *India, Epidemiology, Potable water, Human diseases, Liver, Water pollution, Population exposure, Public health.

Hepatic damage caused by chronic exposure to arsenic has been frequently described. The cases of 13 patients from West Bengal, India, who consumed large amounts of drinking water, are reported. An epidemiological investigation of the study area showed evidence of chronic arsenical dermatosis and hepatomegaly in 62 (92.5%) of 67 members of families who drank contaminated water (arsenic level, 0.2-2 mg/l). In contrast, only six (6.25%) of 96 persons from the same area who drank safe water (arsenic level, < 0.05 mg/l) had non-specific hepatomegaly, while none had skin lesions. Hepatomegaly occurred in all the 13 patients who were studied in detail, although five had splenomegaly. Biopsy of samples of liver from these patients revealed various degrees of fibrosis and expansion of the portal zone that resembled non-cirrhotic portal fibrosis. (Author's abstract)
W89-05310

IMPACT OF TWO APPLICATIONS OF ATRAZINE ON THE PLANKTON COMMUNITIES OF IN SITE ENCLOSURES,
National Museum of Natural Sciences, Ottawa (Ontario). Botany Div.
P. B. Hamilton, G. S. Jackson, N. K. Kaushik, K. R. Solomon, and G. L. Stephenson.
Aquatic Toxicology AQTODQ, Vol. 13, No. 2, p 123-139, October 1988. 6 fig, 4 tab, 29 ref.

Descriptors: *Atrazine, *Pesticides, *Water pollution effects, *Phytoplankton, *Herbicides, *Mortality, Population dynamics, Algal growth, Herbicides, Population exposure, Organic compounds, Lethal limit, Aquatic populations, Lake St. George, Crustaceans.

Atrazine (2-chloro-4-ethylamino-6-isopropylamino-s-triazine) was applied to aquatic enclosures in Lake St. George, Canada (43 degrees, 57 min, 25 sec N, 79 degrees, 26 min, 30 sec W) on June 1, 1983 with a second application 35 days later. A nominal concentration of 0.1 mg/L was used during each application. Compared to single atrazine applications, this multiple treatment was characterized by a more gradual killing of the phytoplankton, a longer period of recovery for the green algal community, and a distinct shift in the taxonomic composition of the affected communities.

Thirteen days after the first application significant declines in the populations of Elakatothrix gelatinosa, Sphairocystis schoeteri, Tetraedron minimum, Oocystis lacustris, and Gymnodinium spp. were observed. Low numbers persisted after the second application and remained lower for 114 days. Populations of Rhodomonas minuta increased significantly on day 13, whereas those of Cryptomonas erosa were not influenced by the herbicide. On average, there was a reduction from 22 to 16 prominent phytoplankton taxa after atrazine exposure. The similarity between phytoplankton communities in control and atrazine-exposed enclosures, as measured by the Morisita coefficient of association, was distinctly altered after the second atrazine application. This dissimilarity persisted for 77 days. In the spring of 1984, 323 days after the first atrazine application, the control and atrazine exposed enclosures had returned to similar phytoplankton assemblages. The rotifer community was not significantly affected. Two crustaceans, Bosmina longirostris, and Diaptomus oregonensis, had significant short term reductions in numbers after the second application. These reductions were not observed after the first atrazine applications and it is suggested that their decline is a secondary effect caused by changes in other populations within the community. (Author's abstract)
W89-05314

LEUCOCYTES AND LEUCOPOIETIC CAPACITY IN GOLDFISH, CARASSIUS AURATUS, EXPOSED TO SUBLETHAL LEVELS OF CADMIUM,
Brock Univ., St. Catharines (Ontario). Dept. of Biological Sciences.
A. Murad, and A. H. Houston.
Aquatic Toxicology AQTODQ, Vol. 13, No. 2, p 141-154, October 1988. 1 fig, 3 tab, 22 ref. Natural Sciences and Engineering Research Council Individual Operating Grant A6972.

Descriptors: *Water pollution effects, *Toxicity, *Heavy metals, *Cadmium, *Sublethal effects, *Goldfish, Fish physiology, Blood, Biochemistry, Biological properties, Lethal limit, Population exposure.

By comparison with animals in essentially cadmium-free water (< 2 micrograms Cd(2+)/L) goldfish exposed for 3 wk to 90, 270 and 445 micrograms Cd(2+)/L (5, 15, and 25% 240-h LC50) exhibited significant reductions in total leucocyte counts. These were the result of decreases in lymphocyte and thrombocyte numbers. Mitogenic response to administered phytohemagglutinin (PHA) as well as sharp decreases in blast cell numbers suggested that lympho- and thrombopenia reflect, in part at least, decreased proliferative capacity. By contrast, neutrophil, eosinophil and basophil numbers increased in cadmium-intoxicated fish. Cadmium apparently reduced PHA-related changes in granulocyte abundances. (Author's abstract)
W89-05315

IMMUNOHISTOCHEMICAL DETECTION OF CCL4-INDUCED MITOSIS-RELATED DNA SYNTHESIS IN LIVERS OF TROUT AND RAT,
West Virginia Univ. Medical Center, Morgantown. Dept. of Pharmacology.
For primary bibliographic entry see Field 5A.
W89-05316

CYTOCHROME P-450 AND PHASE II ACTIVITIES IN THE GUMBOOT CHITON CRYPTOCHITON STELLERI,
Oregon State Univ., Corvallis. Dept. of Agricultural Chemistry.
D. Schlenk, and D. R. Buhler.
Aquatic Toxicology AQTODQ, Vol. 13, No. 2, p 167-182, October 1988. 5 tab, 48 ref. National Institutes of Environmental Health Sciences Grants ES00210, ES03850, and ES07060.

Descriptors: *Aromatic compounds, *Water pollution effects, *Population exposure, *Chiton, *Enzymes, Organic compounds, Biochemistry, Metabolism, Carcinogens.

The digestive gland of Cryptochiton stelleri was shown to contain cytochrome P-450, benzo(a)pyrene hydroxylase (BPH), and NAPHH-cytochrome P-450 reductase. Glutathione S-transferase, UDP glucuronosyltransferase, and UDP-glucosyltransferase activities also were observed. After treating chitons three weeks with a cytochrome P-450 inducer, beta-naphthoflavone (BNF), a significant ($P < 0.05$) increase in BPH was found in treated animals. The major metabolites extracted after incubation of BP with chiton digestive gland microsomes were quinones. However, a quantitative difference in quinone production was seen between controls (72.7%) and BNF-treated animals (42.9%). Neither ethoxycoumarin-O-deethylase (ECOD) or ethoxyresorufin-O-deethylase (EROD) was detected in controls or BNF-treated animals. (Author's abstract)
W89-05317

DRINKING WATER SOURCE, DIARRHEAL MORBIDITY, AND CHILD GROWTH IN VILLAGES WITH BOTH TRADITIONAL AND IMPROVED WATER SUPPLIES IN RURAL LESOTHO, SOUTHERN AFRICA,
Johns Hopkins Univ., Baltimore, MD. Dept. of International Health.
S. A. Esrey, J. Habicht, M. C. Latham, D. G. Sisler, and G. Casella.
American Journal of Public Health AJHEAA, vol. 78, No. 11, p 1451-1455, November 1988. 7 tab, 14 ref. USAID Grant 632-0088-5-00-4012-00, Cornell Univ. Surveillance Program Cooperative Agreement. AID DSAN CA-0240.

Descriptors: *Water treatment, *South Africa, *Drinking water, *Water pollution, *Water pollution effects, *Public health, *Human diseases, *Human pathology, *Africa, Water supply, Morbidity, Data collections, Water use, Population exposure.

The growth and morbidity rates of young children in relation to exclusive and non-exclusive use of improved water supplies in rural Lesotho, southern Africa are examined. Data were collected for 247 children 60 months of age and under between July 1984 and February 1985 in 10 villages that had an improved water supply at least one year prior to investigation. Children whose families relied exclusively on the new water supply for their drinking and cooking needs grew 0.438 cm and 235 g more in six months than children whose families supplemented the new water supply with the use of contaminated traditional water for drinking and cooking. The difference in growth was greater among children over 12 months of age at the start of the evaluation than among infants. This may be explained partly by lower rates for Giardia lamblia, the most commonly identified pathogen in stools in older children. Among infants, similar rates of Campylobacter, the most commonly isolated pathogen among infants, may have prevented larger differences. Results suggest that improved drinking water supplies can benefit preschool children's health after infancy, but only if they are functioning and utilized exclusively for drinking and cooking purposes. (Author's abstract)
W89-05320

EFFECT OF VARIOUS NUCLEOPHILES ON THE MUTAGENICITY OF SOFTWOOD CRAFT CHLORINATION EFFLUENT,
Kyushu Univ., Fukuoka (Japan). Dept. of Forest Products.
S. Tachibana, J. Santodonato, and C. W. Dence.
Chemosphere CMSHAF, Vol. 17, No. 7, p 1343-1354, 1988. 8 fig, 1 tab, 24 ref.

Descriptors: *Detoxification, *Kraft mill wastes, *Pulp wastes, *Water pollution effects, *Toxicity, *Mutagenic effects, *Chemical properties, *Chlorination, *Chemical reactions, Biochemical properties, Nucleophiles, Organic compounds, Glutathione.

The mutagenicity of softwood kraft chlorination effluent in the Ames Salmonella assay was measured in the presence of various added nucleophiles. The relative effectiveness of the applied nucleophiles in reducing the mutagenicity of the effluent was in the order of OH(-) > SO2 (HSO3(-), SO3(2-)) > glutathione > pyrrolidine > S2O3(2-), which appeared to follow in order of decreasing nucleophile basicity. Both the carbonyl group and organically bound chlorine contents of the effluent decreased upon addition of nucleophiles. In all cases, carbonyl loss appeared to be the more important factor in controlling mutagenicity reduction. The conclusion is drawn that deactivation of kraft chlorination effluent, and possibly the chlorination products of other types of naturally occurring organic material (e.g., humic acid), may be achieved by treatment with any appropriate nucleophile. Effective nucleophiles can include substances such as glutathione, which is endogenous to all mammals, and as such may represent the biochemical basis for a detoxication mechanism. (Author's abstract)
W89-05332

EFFECTS OF LOW PH ALONE AND COMBINED WITH COPPER SULPHATE ON BLOOD PARAMETERS OF RAINBOW TROUT,
Bristol Univ. (England). Research Unit for Comparative Animal Respiration.
G. M. Hughes, and J. Nemcsok.
Environmental Pollution ENPOEK, Vol. 55, No. 2, p 89-95, 1988. 2 fig, 2 tab, 14 ref.

Descriptors: *Acid rain effects, *Acidity, *Copper sulfate, *Toxicity, *Trout, *Water pollution effects, Blood, Fish, Tissue analysis, Sulfuric acid, Enzymes, Fish physiology, Analysis of variance.

The extent to which the toxic effects of low (0.2 ppm) copper concentrations are potentiated when combined with acid treatment and vice versa were studied in rainbow trout. Exposure to a combination of sulfuric acid at pH 6.5 and copper sulfate was found to have a much greater effect than treatment with the same concentration of either solution alone. This effect was observed for most of the variables examined, but was particularly clear for alanine aminotransferase. Acidification alone did not cause any changes in biochemical variables during the 24-hour treatment except for blood glucose level, reflecting stress. However, acidification significantly potentiated the toxicity of copper sulfate, causing serious disturbance in physiological and biochemical processes, including acetylcholinesterase inhibition. The resulting inhibition of heart function has harmful influences on oxygen uptake and carbon release, and may produce anoxia at the tissue level. It is suggested that, in the presence of acid, the particular ionic status of copper is changed, rendering it, under the conditions of this experiment, more toxic. (Doria-PTT)
W89-05350

EFFECT OF SAFE CONCENTRATIONS OF SOME PESTICIDES ON THYROID IN THE FRESHWATER MURREL, CHANNA PUNCTATUS: A HISTOPATHOLOGICAL STUDY,
Punjab Agricultural Univ., Ludhiana (India). Dept. of Zoology.
P. K. Saxena, and K. Mani.
Environmental Pollution ENPOEK, Vol. 55, No. 2, p 97-105, 1988. 6 fig, 1 tab, 16 ref.

Descriptors: *Pesticide toxicity, *Fish, *Tissue analysis, *Insecticides, *Water pollution effects, *Pesticides, *Toxicity, Pathology, Organophosphorus pesticides, Carbamate pesticides, Organic pesticides, Blood.

The effect of safe application rate (SAR) concentrations of the insecticides fenitrothion 50% EC (an organophosphate) and carbofuran 3% G (a carbamate) on histopathological changes in the thyroid gland of the freshwater murrel (Channa punctatus) were studied during chronic exposure for 120 days (mid-April to mid-August). The studies reveal significant declines in the diameters of the follicle and the colloid of the thyroid, but a significant increase in the height of the epithelium, following exposure to both fenitrothion or carbofuran. In the fenitrothion treatment, invasion by blood corpuscles into the follicular lumen, follow-

ing breakdown of the epithelium, was also observed. The degeneration of the epithelium and the loss of colloid in the follicles suggest that the fenitrothion treatment is more severe than the carbofuran treatment. (Author's abstract)
W89-05351

EGG MASS AND SHELL THICKNESS IN DIPPERS CINCLUS CINCLUS IN RELATION TO STREAM ACIDITY IN WALES AND SCOTLAND,
University Coll., Cardiff (Wales). Dept. of Applied Biology.
S. J. Ormerod, K. R. Bull, C. P. Cummins, S. J. Tyler, and J. A. Vickery.
Environmental Pollution ENPOEK, Vol. 55, No. 2, p 107-121, 1988. 5 fig, 1 tab, 37 ref.

Descriptors: *Eggs, *Acidity, *Streams, *Water pollution effects, *Birds, *Acid rain effects, Wales, Scotland, Hydrogen ion concentration, Regression analysis, Aluminum, Calcium, Invertebrates, Insects, Aquatic insects, Gammarus, Amphipods.

The shell thickness and mass of eggs of the dipper (Cinclus cinclus) collected on streams of different pH in Wales and Scotland were measured. The aluminum, phosphorus, and calcium content of their invertebrate prey were also measured. In a regression analysis, significant at $p < 0.05$, stream pH accounted for up to 7% of the variance in shell thickness, with shells decreasing by 2.5% of the overall mean with each unit of pH decline. In the Welsh sample, differences in shell thickness due to pH were small compared with differences between years across all sites. In data pooled between Scotland and Wales, pH accounted for 17% of the variance in egg mass, but a greater proportion (25%) in Scottish eggs alone. Aluminum concentrations in invertebrates showed no relationship with stream pH, but calcium levels in two insect orders increased significantly with pH. Calcium-rich prey, such as Gammarus, were found only in circumneutral streams. Calcium in the diet of dippers before and during egg formation can be supplemented by the ingestion of calcareous grit, however, such material is unlikely to be available in areas characterized by acid streams. No evidence that aluminum in prey adversely affected dipper eggs was found. (Author's abstract)
W89-05352

COMPARISON OF EFFECTS OF PARAQUAT AND METHIDATION ON ENZYME ACTIVITY AND TISSUE NECROSIS OF CARP, FOLLOWING EXPOSURE TO THE PESTICIDES SINGLY OR IN COMBINATION,
Jozsef Attila Univ., Szeged (Hungary). Dept. of Biochemistry.
B. Asztalos, J. Nemcsok, I. Benedeczky, R. Gabriel, and A. Szabo.
Environmental Pollution ENPOEK, Vol. 55, No. 2, p 123-135, 1988. 8 fig, 27 ref.

Descriptors: *Mehtidathion, *Paraquat, *Pesticide toxicity, *Enzymes, *Carp, *Toxicity, Fish, Pathology, Aquariums, Liver, Water pollution effects, Herbicides, Insecticides, Synergistic effects.

Under aquarium conditions, treatment with the herbicide paraquat (PQ) and with the insecticide methidathion (MD) caused cell damage and stress in carp (Cyprinus carpio), as shown by increases in glutamate-dehydrogenase, glutamate-oxalacetate transaminase, and lactate dehydrogenase activities and in blood sugar levels. PQ proved synergistic with MD in certain cases as regards the harmful effect exerted. On combined treatment, dilated extracellular spaces were visible by light microscope in the liver, while electron microscope studies revealed signs indicative of cell autolysis in the same organ. (Author's abstract)
W89-05353

EFFECTS OF 2,4-D HERBICIDE AND ORGANOPHOSPHORUS INSECTICIDES ON GROWTH, PHOTOSYNTHESIS, AND CHLOROPHYLL A SYNTHESIS OF CHLAMYDOMONAS REINHARDTII (MT +),
Chinese Univ. of Hong Kong. Shatin. Dept. of Biology.
P. K. Wong, and L. Chang.
Environmental Pollution ENPOEK, Vol. 55, No. 3, p 179-189, 1988. 1 fig, 3 tab, 30 ref.

Descriptors: *Herbicides, *Organophosphorus pesticides, *Pesticide toxicity, *Growth, *Photosynthesis, *Chlorophyll a, *Chlamydomonas, *Algae, *Pesticides, Insecticides, Organic pesticides, Toxicity, Chlorophyta, Algal growth, Water pollution effects.

The effects of the herbicide (2,4-D) and six organophosphorus insecticides (Diazinon, Dimethoate, Fenitrothion, Malathion, Phenthoate, and Quinalphos) on growth, photosynthesis, and chlorophyll a synthesis of the fresh water green alga Chlamydomonas reinhardtii were studied. At low concentrations (1 and 5 ppm), the herbicide and all six organophosphorus insecticides stimulated photosynthesis of the alga. The stimulating effects on algal growth and chlorophyll a synthesis were observed only in the presence of low concentration (1 ppm) of 2,4-D and Fenitrothion. Growth, photosynthesis, and chlorophyll a synthesis of the alga were inhibited in the presence of high concentrations (10, 20, and 40 ppm) of the herbicide and all the six organophosphorus insecticides. Results also indicated that the toxicities of these organophosphorus insecticides on the tested alga were dependent on their chemical structures. (Author's abstract)
W89-05356

EVALUATION OF ALTERNATIVE OIL SPILL CLEANUP TECHNIQUES IN A SPARTINA ALTERNIFLORA SALT MARSH,
Texas A and M Univ. at Galveston. Dept. of Marine Biology.
For primary bibliographic entry see Field 5G.
W89-05357

LONG-TERM EFFECT OF AMMONIUM SULFATE FERTILIZER ON HISTOPHYSIOLOGY OF ADRENAL IN THE TELEOST, CHANNA PUNCTATUS (BLOCH),
Banaras Hindu Univ., Varanasi (India). Centre of Advanced Study in Zoology.
R. N. Ram, and S. K. Singh.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 41, No. 6, p 880-887, December 1988. 5 fig, 18 ref.

Descriptors: *Fertilizers, *Ammonium compounds, *Fish physiology, *Toxicity, *Water pollution effects, Sulfates, Animal physiology, Gills, Agricultural chemicals.

The histopathological changes in adrenal components and pituitary corticotrophs were investigated in a freshwater air-breathing teleost, Channa punctatus, in response to prolonged exposure of six months to safe (100 ppm) and sublethal (500 ppm) doses of ammonium sulfate fertilizer. Following treatment, the cortical cells in both groups of fish revealed extensive hyperplasia, degranulation, involution, and exhaustion, probably after prolonged hyperactivity. These changes were more pronounced in sublethal dose treated fish than in safe dose treated fish. The chromaffin cells in safe dose treated fish showed slight hypertrophy, whereas in those exposed to sublethal dose these cells exhibited atrophic changes characterized by reduction in size, pyknosis, and nuclear necrosis leading to cellular involution. The metabolic significance of these changes is discussed. It is concluded that ammonium sulfate fertilizer, which is washed into the water systems in small quantities, can inhibit adrenal function and induce cellular degeneration either by direct action on the adrenal itself or indirectly via the hypothalamo-pituitary-adrenal axis in this species in a dose-dependent manner. (Doria-PTT)
W89-05361

DEHYDROABIETIC ACID (DHAA) DOES NOT INHIBIT BILIRUBIN CONJUGATION IN THE LIVER OF RAINBOW TROUT,
Helsinki Univ. (Finland). Dept. of Zoology.
L. Mattsoff, and M. Nikinmaa.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 41, No. 6, p 894-901, December 1988. 3 fig, 1 tab, 19 ref.

Descriptors: *Resins, *Organic acids, *Liver, *Trout, *Fish physiology, *Toxicity, Acids, Animal physiology, Water pollution effects, Enzymes, Metabolism, *Pulp wastes, Wastes, Industrial wastes, Pulp and paper industry, Effluents.

High concentrations of resin acids from pulp and paper mill effluent cause jaundice in exposed fishes. in high concentrations. Detoxification of these compounds by the liver is achieved by conjugation with glucuronic acid via the enzyme UDP-glucuronyltransferase (UDP-GT). Experiments were conducted in rainbow trout to determine whether the competition between resin acids and bilirubin for the conjugation is partly responsible for the development of jaundice by measuring the activity of bilirubin UDP-GT in vitro in the presence of a resin acid, dehydroabietic acid (DHAA). Results showed that the bilirubin conjugation activity of liver tissue was not affected by DHAA in the incubation mixture at either of two DHAA concentrations used (0.012 mM and 0.06 mM). This shows that bilirubin and DHAA do not compete for conjugation in the liver under these conditions. The lack of competition between DHAA and bilirubin does not seem to be caused by the binding of DHAA to albumin, since the conjugation activities of samples with and without DHAA were similar even in the absence of albumin. It is suggested that different forms of UDP-GT conjugate bilirubin and DHAA, and that inhibition of bilirubin conjugation does not play a role in the development of jaundice. Resin-induced jaundice in rainbow trout may result partly from accelerated red cell hemolysis and partly from the inhibition of the secretion of bilirubin from blood to bile. (Doria-PTT)
W89-05363

TOXIC EFFECTS OF MERCURIC CHLORIDE, METHYLMERCURIC CHLORIDE, AND EMISAN 6 (AN ORGANIC MERCURIAL FUNGICIDE) ON OVARIAN RECRUDESCENCE IN THE CATFISH CLARIAS BATRACHUS (L.),
Banaras Hindu Univ., Varanasi (India). Centre of Advanced Study in Zoology.
R. Kirubagaran, and K. P. Joy.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 41, No. 6, p 902-909, December 1988. Government of India Dept. of Environment, Grant 19/55/79-Env.

Descriptors: *Toxicity, *Mercury, *Catfish, *Metal organic pesticides, *Pesticides, *Water pollution effects, *Fungicides, Heavy metals, Pesticides, Organic pesticides, Fish, Histology, Metal complexes, Fish physiology, India, Histology.

Different groups of fish from the Gangetic river system (India) were exposed 9 and 180 days in the laboratory to safe concentrations of 0.05 mg/L mercuric chloride, 0.04 mg/L methylmercuric chloride, and 0.5 mg/L emisan 6 The gonadosomatic index (GSI) decreased significantly in treated fish compared to the control groups. In all treated groups, the oocytes were in non-vitellogenic stage. In the HgCl2 and CH3HgCl treated groups, several oocytes were degenerated. The cytoplasm was liquefied, resulting in empty spaces. The granulosa layer became hypertrophied and thickened greatly, and contained phagocytosed remnants of oocyte cytoplasmic material. The ovary was extensively infiltrated with fibroblast-like cells in one fish each from the 90-day emisan and 180-day HgCl treated groups. The yolk nucleus exhibited degenerative changes in the CH3HgCl and emisan treated groups, and was even resorbed leaving empty spaces in the cytoplasm. It is concluded that a very low concentration of Hg is capable of completely inhibiting ovarian recrudescence in fish, no matter what form of Hg is used. (Doria-PTT)
W89-05364

AMES MUTAGENICITY AND CONCENTRATION OF THE STRONG MUTAGEN 3-CHLORO-4-(DICHLOROMETHYL)-5-HYDROXY-2(5H)-FURANONE AND OF ITS

GEOMETRIC ISOMER E-2-CHLORO-3-(DICHLOROMETHYL)-4-OXO-BUTENOIC ACID IN CHLORINE-TREATED TAP WATERS,
Abo Akademi, Turku (Finland). Dept. of Organic Chemistry.
L. Kronberg, and T. Vartiainen.
Mutation Research MUREAV, Vol. 206, No. 2, p 177-182, October 1988. 3 fig, 3 tab, 22 ref.

Descriptors: *Mutagenicity, *Toxicity, *Water pollution effects, *Drinking water, *Organic compounds, *Humic acids, *Chlorination, *Water treatment, Finland, Disinfection, Correlation analysis, Water pollution sources, Contamination.

The Ames mutagenicity and the concentration of the strong Ames mutagen 3-chloro-4-(dichloromethyl)-5-hydroxy-2(5H)-furanone (MX) and its geometric isomer E-2-chloro-3-(dichloromethyl)-4-oxo-butenoic acid (E-MX), derived from chlorination of humus, were determined in extracts of tap water collected from 26 localities in Finland. The 23 tap waters treated with disinfectants gave a positive response in strain TA100. MX and E-MX were detected in all extracts exhibiting mutagenicity with the exception of 3 extracts of marginal activity. MX accounted for 15-57% (average 33%) of the observed mutagenicity. The concentration of E-MX was slightly lower than the corresponding concentration of MX. Linear correlations were observed between mutagenicity and concentration of MX and E-MX, with correlation coefficients of 0.894 for MX and 0.910 for E-MX. (Author's abstract)
W89-05367

ACID RAIN: RHETORIC AND REALITY,
Lancaster Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 5B.
W89-05427

OIL IN FRESHWATER: CHEMISTRY, BIOLOGY, COUNTERMEASURE TECHNOLOGY.
Proceedings of the Symposium of Oil Pollution in Freshwater, Edmonton, Alberta, Canada. Pergamon Press, New York, NY, 1987. 512p. Edited by John H. Vandermeulen and Steve E. Hrudey.

Descriptors: *Oil pollution, *Oil spills, *Path of pollutants, *Wastewater treatment, *Cleanup operations, *Water pollution effects, Conferences, Hydrocarbons, Biodegradation, Groundwater pollution, Urban runoff, Oil wastes, Oily water, Aquatic life, Toxicity, Gasoline, Oil recovery.

This volume is a compilation of selected papers which were presented at an International Conference on Oil in Freshwater held in Edmonton, Alberta, Canada in October 1984. The papers are grouped under five chapters that describe various aspects of petroleum interaction and contamination in freshwater environments. The first chapter deals with the chemistry and fate of hydrocarbons in freshwater environments. Chapter Two discusses oil in runoff and groundwater. In Chapter Three, the biodegradation of hydrocarbons, the fate of polynuclear aromatic hydrocarbons in soil, and the effect of oil dispersants on microbially-mediated processes in freshwater systems are discussed. Chapter Four examines the effects of oil and chemical dispersants on freshwater organisms and aquatic communities. In Chapter Five technology for the removal of hydrocarbons from surface and groundwater is covered along with countermeasures, treatment and disposal of hydrocarbons. (See W89-05431 thru W89-05464) (Geiger-PTT)
W89-05430

CHEMICAL AND PHYSICAL BEHAVIOUR OF HYDROCARBONS IN FRESHWATER,
Toronto Univ. (Ontario). Inst. for Environmental Studies.
For primary bibliographic entry see Field 5B.
W89-05432

EFFECT OF OIL DISPERSANTS ON MICROBIALLY-MEDIATED PROCESSES IN FRESHWATER SYSTEMS,
Alberta Univ., Edmonton. Dept. of Microbiology.
J. M. Foght, N. J. Fairbairn, and D. W. S. Westlake.
IN: Oil in Freshwater: Chemistry, Biology, Countermeasure Technology. Pergamon Press, New York, NY, 1987. Edited by John H. Vandermeulen and Steve E. Hrudey. p 252-263, 8 fig, 3 tab, 16 ref.

Descriptors: *Oil pollution, *Dispersants, *Microbial degradation, *Nitrogen fixation, *Water pollution effects, Nitrogen fixing bacteria, Fate of pollutants, Enzymes, Radiometry, Gas chromatography, Bottom sediments, Lake sediments, Biodegradation.

The effect of 15 oil dispersants on the microbial degradation of Norman Wells oil has been investigated using capillary gas chromatography (CGC) and C14-radiometric techniques. Other ecologically important microbial biochemical processes, such as phosphatase, aerobic and anaerobic nitrogen fixation, and methane production in natural waters and sediments were studied with selected dispersants. Several dispersants, when used at manufacturers' recommended rates, were found by CGC to have slightly stimulatory or no inhibitory effects on oil degradation under laboratory conditions. Other dispersants were toxic or inhibited degradation. The CGC results were confirmed by C14-labelled CO2 evolution from labelled substrates in laboratory cultures and natural waters. Phosphatase activity was stimulated by 2 of 4 dispersants tested in the presence of oil. In the absence of oil, all 4 dispersants stimulated phosphatase activity. Aerobic N2-fixation was stimulated by three dispersants, while anaerobic N2-fixation was stimulated only at high concentrations of dispersants. One dispersant stimulated methane production in anaerobic sediments, in proportion to the dispersant concentration. (See also W89-04530) (Author's abstract)
W89-05448

TOXICITY AND SUBLETHAL EFFECTS OF PETROLEUM HYDROCARBONS IN FRESHWATER BIOTA,
Bedford Inst., Dartmouth (Nova Scotia). Marine Ecology Lab.
J. H. Vandermeulen.
IN: Oil in Freshwater: Chemistry, Biology, Countermeasure Technology. Pergamon Press, New York, NY, 1987. Edited by John H. Vandermeulen and Steve E. Hrudey. p 267-303, 8 fig, 13 tab, 173 ref.

Descriptors: *Oil pollution, *Toxicity, *Water pollution effects, *Aquatic animals, *Sublethal effects, *Aquatic plants, Waterfowl, Water birds, Hydrocarbons, Algae, Environmental effects, Biological magnification, Ecological effects, Literature review, Fish, Oil spills.

Contrary to the situation for the marine environment, research on effects of petroleum hydrocarbons on freshwater biota is surprisingly limited and is restricted generally to only a few animal and plant genera. In several instances, a single study of acute toxicity on a single species is the only information available for that species, and is not confirmed elsewhere. An attempt was made to bring together and summarize the available research literature on freshwater organisms and to present the interpretations and summary conclusions on the impact and mechanism of the toxicology of petroleum hydrocarbons in the freshwater environment. Included in this discussion are the acute lethal and sublethal toxicity of petroleum and petroleum compounds, mutagenicity, and effects on birds and freshwater algae. Toxicity of petroleum varies with the type of product and its state of weathering, its chemical composition, and degree of impact varies with the age and life cycle stage of the organism affected. These aspects are also reviewed. The review includes summary tables of acute lethal and sublethal toxicities of petroleum as they have been determined on a range of freshwater organisms. Focus has been on the literature published since 1979. (See also W89-04530) (Author's abstract)
W89-05449

PHOTOINDUCED TOXICITY OF POLYCYCLIC AROMATIC HYDROCARBONS TO AQUATIC ORGANISMS,
National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.
P. F. Landrum, J. P. Giesy, J. T. Oris, and P. M. Allred.
IN: Oil in Freshwater: Chemistry, Biology, Countermeasure Technology. Pergamon Press, New York, NY, 1987. Edited by John H. Vandermeulen and Steve E. Hrudey. p 304-318, 5 fig, 82 ref.

Descriptors: *Toxicity, *Aromatic hydrocarbons, *Photodegradation, *Water pollution effects, *Great Lakes, Aquatic life, Daphnia, Bluegills, Sunfish, Bioaccumulation, Photoactivation, Crustaceans, Insects, Phytoplankton, Algae, Bacteria, Amphibians, Light penetration.

Polycyclic aromatic hydrocarbons (PAH) such as anthracene are ubiquitous pollutants that are normally not considered acutely toxic to aquatic organisms because they are only sparingly soluble in water. Thus, bioassays conducted under the usual laboratory conditions have resulted in estimates of acute toxicity that exceed the aqueous solubilities of PAH. However, these studies are usually conducted under conditions that minimize photodegradation, and therefore the potential to observe ecologically relevant photoinduced toxicity is eliminated. Studies under more ecologically relevant conditions in an illuminated artificial stream microcosm have demonstrated that anthracene is acutely toxic (100% mortality) to juvenile bluegill sunfish at 12 micrograms/L in less than 9 hr. This toxicity is more than 400 times greater than previously reported no-effect concentrations. Daphnia pulex are even more sensitive (LT50, time to 50% immobilization - 13 min at 1.2 micrograms/L). These dramatic effects occur as a result of the interaction of bioaccumulated parent PAH and light, not the action of externally formed photodegradation products. Preliminary screening has indicated that benzo(a)pyrene is even more toxic than anthracene. It is predicted that 50% of the aquatic organisms in a lake will be immobilized at a depth of 7.25 m with a 1.2 microgram/L anthracene concentration based on the use of the Bunsen-Roscoe Law of Reciprocity, the measured extinction coefficient for UV-B in Lake Michigan (0.575/m), an average summer day length of 14 hr, and the LT50 for Daphnia pulex. These effects, the depths at which they may be occurring, and the concentrations of PAH in the Great Lakes indicate that acute effects could be occurring at present in the Lakes. With expected increases in PAH load due to increased coal usage and increased ambient levels of solar UV due to depletion of the ozone layer, the potential exists for large effects in the Great Lakes and other aquatic systems. (See also W89-04530) (Author's abstract)
W89-05450

GENOTOXIC AND CARCINOGENIC ACTIVITY OF OIL REFINERY EFFLUENTS,
Trent Univ., Peterborough (Ontario). Environmental and Resource Studies Program.
C. D. Metcalfe, and R. A. Sonstegard.
IN: Oil in Freshwater: Chemistry, Biology, Countermeasure Technology. Pergamon Press, New York, NY, 1987. Edited by John H. Vandermeulen and Steve E. Hrudey. p 319-334, 9 fig, 6 tab, 31 ref.

Descriptors: *Oil pollution, *Trout, *Water pollution effects, *Carcinogens, Industrial wastes, Mutagenicity, Oil spills, Bioassay, Oil refineries, Particulate matter, Canada.

The mutagen and carcinogen burden associated with the discharge of oil refinery effluents from three refineries in Ontario, Canada, into bodies of freshwater was examined. Concentrated extracts were prepared from particulate and dissolved components of refinery effluents and tested for genotoxic activity using the Ames bacterial mutagenicity assay, and an in vitro assay for sister-chromatid exchanges (CHO). These studies indicate that the particulate component of effluents shows genotoxic activity, and activity is concentrated in polar, neutral subfractions of these extracts. Effluent ex-

tracts were tested for carcinogenicity using an in vivo trout embryo assay. Refinery extracts were not carcinogenic, but they showed co-carcinogenic activity when combined with the hepatic carcinogen, aflatoxin B1. (See also W89-04530) (Author's abstract)
W89-05451

ACUTE TOXICITY BIOASSAYS WITH PETROLEUM PRODUCTS: INFLUENCE OF EXPOSURE CONDITIONS,
Department of Fisheries and Oceans, Winnipeg (Manitoba). Freshwater Inst.
For primary bibliographic entry see Field 5A.
W89-05452

REVIEW OF OIL AND BIOLOGICAL COMMUNITY RESPONSES IN NORTHERN RIVERS,
Dominion Ecological Consulting Ltd., Calgary (Alberta).
R. R. Wallace.
IN: Oil in Freshwater: Chemistry, Biology, Countermeasure Technology. Pergamon Press, New York, NY, 1987. Edited by John H. Vandermeulen and Steve E. Hrudey. p 345-352, 2 fig, 1 tab, 36 ref.

Descriptors: *Bioindicators, *Oil pollution, *Oil spills, *Water pollution effects, *Cold regions, Bacteria, Algae, Benthos, Canada, Biomass, Biodegradation, Rivers, Microbial degradation, Fate of pollutants.

The use of specific organisms as indicators of stress from pollution of oils spilled into fresh waters has proven to be a useful tool in quantifying the physical or chemical effects of such compounds. Such assessments, however, often overlook the interactive responses to oils, either positive or negative, by bacterial, algal, and macrobenthic communities in lotic or lentic habitats. The complex interactions which are known to arise shortly after oil additions are not limited to warmer waters. Indeed, in cold brown-water rivers in northern Alberta which cut through oilsands deposits, the capability of river microorganisms to degrade oil at temperatures as low as 4 C has been established. Field experiments which measure community responses to oil indicate that interactions between components of the micro- and macrobenthic communities may determine the final, observed responses in macrobenthic indicator organisms. General increases for example in microbial numbers and biomass associated with substrata, experimentally contaminated with synthetic crude oil (SCO), were probably due to direct or indirect stimulation of microflora by the oil. Benthic invertebrates, in turn, responded to the increased supply of food and occurred in increased abundance in the oiled substrates. The role of benthic communities in the degradation of oils, including the several fractional components, of such oil, and their eventual translocation through lotic ecosystems needs to be carefully evaluated, especially for the cold waters of large rivers which receive oily effluents. (See also W89-04530) (Author's abstract)
W89-05453

ASSESSMENT OF DAMAGE TO AQUATIC COMMUNITIES RESULTING FROM A REFINED OIL PRODUCTS SPILL,
Mary Washington Coll., Fredericksburg, VA. Dept. of Biological Sciences.
M. L. Bass, J. R. Voshell, and R. W. Young.
IN: Oil in Freshwater: Chemistry, Biology, Countermeasure Technology. Pergamon Press, New York, NY, 1987. Edited by John H. Vandermeulen and Steve E. Hrudey. p 353-378, 13 fig, 9 tab, 26 ref.

Descriptors: *Oil spills, *Oil pollution, *Water pollution effects, *Fuel, Aquatic life, Benthos, Biomass, Population density, Species diversity, Ecological effects, Diatoms.

In March 1980 two simultaneous breaks in Colonial Pipeline Company's refined oil products line in Northern Virginia spilled approximately 340 cu m of No. 2 fuel oil into Mine Run Creek and approximately 120 cu m of kerosene into Bull Run Creek. Damage to these streams was assessed by analyzing water chemistry, sediment total chromatographable organics (TCO), periphyton and macrobenthic community structures. Periphyton samples were taken using a bar-clamp sampler and analyzed by cell counting and biomass estimates using ash-free dry weight (AFDW). Macrobenthos was sampled using a PIBS and D-frame Net Kick Sampler. After macrobenthos identification and enumeration, samples were sorted into trophic functional groups and their biomass was reported as AFDW. The effects of the refined products spill were most evident in Mine Run Creek with reduced standing crop, density and taxa number. The collector-filter group was reduced while the collector-gatherers and scrapers were more abundant at the affected sites. There was no clear evidence of long term adverse impacts to the communities in Bull Run Creek. The low density of the communities and the reduction or absence of certain functional groups in Mine Run Creek indicates continued perturbation. Increased bacterial biomass correlated with the increased scrapers at impacted stations. Diatoms were dominant periphyton in the streams in 1980 and 1981. Qualitative evaluations of Mine Run indicate recovery is continuing. (See also W89-04530) (Author's abstract)
W89-05454

COLONIZATION OF EXPERIMENTALLY OILED SUBSTRATES BY PERIPHYTON AND BENTHIC MACROINVERTEBRATES IN TWO ARCTIC STREAMS,
Aquatic Environments Ltd., Calgary (Alberta).
P. McCart, and J. Denbeste.
IN: Oil in Freshwater: Chemistry, Biology, Countermeasure Technology. Pergamon Press, New York, NY, 1987. Edited by John H. Vandermeulen and Steve E. Hrudey. p 388-402, 2 fig, 6 tab, 23 ref.

Descriptors: *Oil pollution, *Oil spills, *Invertebrates, *Water pollution effects, *Species diversity, Bioindicators, Benthos, Biomass, Population density, Alaska, Fate of pollutants.

The recolonization by periphyton and benthic macroinvertebrates onto cleaned natural surfaces oiled with Prudhoe Bay crude oil and placed into the streambeds of two streams located within the Trans Alaska Pipeline Corridor in northern Alaska (Oksrukuyik Creek and Airstrip Creek) is described. Non-oiled natural surfaces served as controls. The sites were revisited and sampled at 45 days and 90 days after the placement of the oiled surfaces in the streams. Oil residue was still evident on the surfaces (large stones) in both streams after 90 days exposure. In both streams, periphyton communities increased in numbers during the initial 45 days on oiled surfaces with respect to non-oiled control surfaces. However, because of the high variance in the data and the small sample sizes, few differences between oiled and control substrates were significant. There was no consistent pattern of differences between community parameters for oiled and control substrates. Some individual taxa did differ, however, particularly Candona (Ostracoda) and Podmosta (Plecoptera), both of which appeared markedly reduced on the oiled surfaces, and which may be useful as indicator organisms in the study area. There were individual differences between the two streams as well. Thus density, biomass, and taxonomic diversity of periphyton were all lower in Oksrukuyik Creek than in Airstrip Creek. Densities and taxonomic diversity of benthic macroinvertebrates were higher in Oksrukuyik than in Airstrip Creek. Apparently, for the time period investigated, recolonization by both the periphyton and macroinvertebrate communities was little influenced by the presence of oil on the settling substrates. (See also W89-04530) (Author's abstract)
W89-05456

EFFECTS OF OIL AND OIL SPILL CHEMICALS ON SHORELINE PLANTS OF NORTHERN FRESHWATER ECOSYSTEMS,
Alberta Univ., Edmonton. Dept. of Botany.
D. Blundon, M. Dale, S. Goudey, and J. Hoddinott.
IN: Oil in Freshwater: Chemistry, Biology, Countermeasure Technology. Pergamon Press, New York, NY, 1987. Edited by John H. Vandermeulen and Steve E. Hrudey. p 403-409, 4 tab, 19 ref.

Descriptors: *Oil spills, *Oil pollution, *Aquatic plants, *Water pollution effects, *Dispersants, Toxicity, Canada, Plant growth, Moss, Willow trees, Lichens, Photosynthesis, Ecological effects, Cold regions.

The effects of the dispersants Corexit 9600 and 7664 and a reference toxicant (sodium lauryl sulfate), in the presence of northern freshwater ponds were assessed. The responses of five species, Salix interior (sandbar willow), Carex aquatilis (sedge), Sphagnum warnstorfii (sphagnum moss), Cladina mitis (reindeer lichen), and Picea mariana (black spruce), each representing a different growth form, to the dispersants and dispersed oil were examined under controlled environment conditions (12 C). Initial growth and recovery after dormancy were evaluated. Oil sprayed on foliage or poured onto soil caused the most damage; no willow or moss survived. Plants that survived an oil treatment were not adversely affected by the spraying of dispersants. The effects of Corexit 7664 alone were less severe than those of Corexit 9600. The sedge and to a lesser extent the willow and lichen were the most tolerant of all treatments; the moss and black spruce were the most sensitive. The use of these species and other methods for assessing the toxic effects of oil spill chemicals and crude oil in the development of bioassay methods are considered. The most visible and greatest short term effects of crude oil spills and dispersant use on shoreline communities will be defoliation and a reduction in above ground plant cover. (See also W89-04530) (Author's abstract)
W89-05457

LAST STAND OF THE RED SPRUCE,
R. A. Mello.
Island Press, Washington, DC. 1987. 199p.

Descriptors: *Air pollution effects, *Spruce trees, *Legislation, *Acid rain, *Water pollution effects, Water pollution sources, Path of pollutants, Regulations, Forests, Ecological effects, Electric powerplants, Mortality, Vermont, West Germany, Canada, New England.

By most accounts, acid rain appears to be the culprit in the steady decline of the red spruce. This well documented book adds ammunition to the arsenal of those advocating control of acid rain. The author makes a strong call for reducing acid rain emissions and establishes the need for immediate action. The red spruce began to die in Vermont during the 1950s. But Vermont is not alone in witnessing the suffering of these graceful trees. All of New England and Canada and states as far south as Georgia are experiencing the same loss. Scrubbers and other methods were developed and improved through the 1970s and are now proven reliable means of controlling emissions from both new and existing power plants. In West Germany, where 'Waldsterben' has long been a national concern, an acid rain control program is now being implemented. Under legislation enacted there in 1983, every large coal-fired plant in West Germany which will operate past 1993 is being required to install and operate a high-efficiency FGD system by the beginning of 1988. This book presents information to the lay reader concerning all aspects of the sources, pathways, effects and legislation concerning acid rain on the stands of red cedar, and other coniferous forests, in the United States. (Lantz-PTT)
W89-05507

UNITED NATIONS ENVIRONMENTAL PROGRAMME: ENVIRONMENTAL DATA REPORT.
Monitoring and Assessment Research Centre, London (England).
For primary bibliographic entry see Field 5B.
W89-05512

WATER AND SEDIMENT QUALITY IN THE CALCASIEU RIVER/LAKE COMPLEX,

McNeese State Univ., Lake Charles, LA. Dept. of Biological and Environmental Sciences.
For primary bibliographic entry see Field 5B.
W89-05530

CHEMISTRY,
McNeese State Univ., Lake Charles, LA. Dept. of Chemistry.
For primary bibliographic entry see Field 5B.
W89-05532

VEGETATION OF FENS IN RELATION TO THEIR HYDROLOGY AND NUTRIENT DYNAMICS: A CASE STUDY,
Utrecht Rijksuniversiteit (Netherlands). Dept. of Plant Ecology.
J. T. A. Verhoeven, W. Koerselman, and B. Beltman.
IN: Vegetation of Inland Waters. Kluwer Academic Publishers, Boston, MA. Handbook of Vegetation Science Series Vol. 15/1. 1988. p 249-282, 8 tab, 11 fig, 52 ref.

Descriptors: *Saline water intrusion, *Water pollution effects, Polders, *Swamps, *Bogs, *Fens, *Peat bogs, *Marshes, Vegetation, Flora, Plant populations, Macrophytes, Vegetation, Sphagnum, Nutrients, Groundwater recharge, Nitrogen, Phosphorus.

Nutrient availability is shown to be a key factor explaining the differences in species composition between various fens. However, there are other, mainly biotic, factors involved that relate to the water quality aspects other than nutrients per se. Because of the completely different behavior of dead Sphagnum material compared to phanerogam litter in decomposition and mineralization, a Sphagnum carpet causes important changes in the nutrient dynamics of the fens. The break-down of organic matter is slowed down, whereas the mineralization of N and P is accelerated. Further, the growth of phanerogams is for some reason suppressed. The moment of Sphagnum invasion is different for fens in groundwater discharge and groundwater recharge areas. Another factor of great importance is the source of the surface water that is supplied to the fens with groundwater recharge, which in the Netherlands is mostly polluted river water. If this surface water originates from rivers high in NaCl, the species composition is drastically influenced and much of the typical fen community is lost. (See also W89-05543) (White-Reimer-PTT)
W89-05551

RESPONSE OF PLANTS AND VEGETATION TO MINE TAILINGS AND DREDGED MATERIALS,
Vrije Univ., Amsterdam (Netherlands). Dept. of Ecology and Ecotoxicology.
W. H. O. Ernst.
IN: Chemistry and Biology of Solid Waste: Dredged Material and Mine Tailings. Springer-Verlag, New York, NY. 1988. p 54-69, 3 tab, 2 fig, 103 ref.

Descriptors: *Water pollution sources, *Land disposal, *Land reclamation, *Revegetation, *Vegetation establishment, Mine wastes, Spoil banks, Solid waste disposal, Mine wastes, Toxicity, Dissolved oxygen.

The evolution of metal tolerance in terrestrial and aquatic plants gives a sound basis for revegetation of metal-contaminated mine tailings and disposal sites of dredged materials. Prior to every revegetation, a careful analysis has to be carried out to analyze the speciation of heavy metals, the amount of major plant nutrients, the water-holding capacity of the material in terrestrial disposal sites and the dissolved oxygen status in submersed dumps. All these environmental factors determine the selection of the appropriate plant material. The more the disposal sites can be stabilized, the better the areas will be revegetated. Reclamation of mine tailings and disposal sites of dredged materials does not allow the use of these areas for every purpose. It depends on the behavior of possible toxic substances in the turnover and food web of the ecosystem. (See also W89-05555) (White-Reimer-PTT)
W89-05558

CASE HISTORIES OF COASTAL AND MARINE MINES,
Victoria Univ. (British Columbia). Dept. of Biology.
D. V. Ellis.
IN: Chemistry and Biology of Solid Waste: Dredged Material and Mine Tailings. Springer-Verlag, New York, NY. 1988. p 73-100, 6 tab, 9 fig, 71 ref.

Descriptors: *Water pollution effects, *Water pollution prevention, *Mine wastes, *Acid mine drainage, *Mine drainage, Turbidity, Bioaccumulation, Heavy metals, Trace metals, Trace elements, Toxicity, Monitoring.

There are three impacts which have consistently occurred at marine mining sites and will probably occur to a limited extent at new sites even when controlling action is taken. The impacts are water turbidity, seabed smothering and trace metal bioaccumulation. These three kinds of impacts are liable to interact with complex social consequences, but the direct consequences can often be reduced by appropriate controls to levels which have little biological effect. The direct impacts may induce the secondary effects; acute toxicity, trace metal biomagnification, and fishery losses. Controls to reduce these impacts are generally implemented at two stages of the mining process: either in the process stage of milling, and by design, placement or operation of the outfall. Assessment procedures should change during the lifetime of the mine. Initially, assessment by baseline resource surveys and preoperational monitoring allows prediction and prevention of potential impacts. Monitoring is necessary during construction to control stream flow diversion and for impacts such as controllable toxicities. Initial short-term assessments monitor immediate changes in the receiving area followed by long-term assessments for slow changes such as trace metal biomagnification during operation. Finally, monitoring should be undertaken of biological recovery during temporary mine closures, prior to monitoring and control of required reclamation. Assessment should be considered as part of an informational feedback system to the mine developers and operators. (See also W89-05555) (White-Reimer-PTT)
W89-05559

BIOLOGICAL ASSESSMENT OF ENVIRONMENTAL IMPACT OF DREDGED MATERIAL,
Technische Univ. Hamburg-Harburg (Germany, F.R.). Arbeitsbereich Umweltschutztechnik.
W. Ahlf, and M. Munawar.
IN: Chemistry and Biology of Solid Waste: Dredged Material and Mine Tailings. Springer-Verlag, New York, NY. 1988. p 127-142, 1 fig, 76 ref.

Descriptors: *Water pollution effects, *Solid waste disposal, *Dredging, *Spoil banks, *Bioassay, *Environmental effects, Ecological effects, Toxicity, Benthos, Sediments.

Relatively simple and implementable liquid, suspended particulate and solid-phase bioassays have been carried out for assessing the short-term impact of dredging and disposal operations on aquatic organisms. However, short-term and long-term bioassays give only a first estimation for determining potential environmental impacts of the dredging activities. The use of natural algal populations, in situ bioassays, flow-through bioassays and biomonitoring are recommended over static procedures. In addition, bioassays should include at least three different trophic levels. The bioassay results must be interpreted in relation to the field situations and site-specific data. Benthic bioassay procedures are relatively important and should continue to be evaluated to estimate the relationship between laboratory and field impacts. All work for screening potential impacts of contaminated sediments will not be useful if not preceded by an extensive investigation to establish sediment quality criteria for dredging and disposal activities. (See also W89-05555) (White-Reimer-PTT)
W89-05561

DRINKING WATER AND HEALTH,
Wisconsin Univ.-Milwaukee. Dept. of Urban Planning.
G. W. Page.
In: Planning for Groundwater Protection. Academic Press, New York, NY, 1987. p 69-87, 1 fig, 1 tab, 54 ref.

Descriptors: *Water pollution effects, *Drinking water, *Toxicity, *Standards, *Public health, Contamination, Groundwater pollution, Water supply, Carcinogens, Epidemiology, Water pollution preventive.

The human health effects of consuming drinking water containing toxic organic and inorganic substances are poorly understood and the subject of controversy. The public and public officials want clear standards, which define for each toxic chemical the concentration that will not cause adverse health effects. Drinking water supplies may be contaminated by volatile organic compounds, heavy metals, and asbestos. The greatest concern from the long-term exposure to organic contaminants in drinking water is cancer. Both animal studies and epidemiological studies have been used to investigate the relationship between carcinogens in drinking water and cancer. Strongly divergent conclusions exist concerning the relative importance of water as a cancer risk. The consequences of failing to keep drinking water supplies free of microcontaminants are unknown. Intervention to keep these pollutants out of the sources of water supply is the best approach but this approach is not likely to be completely successful. (See also W89-05600) (Stoehr-PTT)
W89-05603

ACID DEPOSITION AND THE ACIDIFICATION OF SOILS AND WATERS,
Colorado State Univ., Fort Collins. Dept. of Agronomy.
J. O. Reuss, and D. W. Johnson.
Springer-Verlag, New York. 1986. 119p.

Descriptors: *Air pollution effects, *Acid rain, *Acidification, *Soil contamination, *Water pollution sources, *Water pollution effects, Ecological effects, Model studies, Groundwater pollution, Ecosystems.

One of the most pressing issues currently facing environmental scientists is the need to predict the effects of acid deposition on terrestrial and aquatic ecosystems. The focus is on those systems in which acid deposition is most widespread and deleterious. Acid deposition effects on the soil-plant system and on the composition of the solution that is released to surface waters and groundwaters were analyzed. With the help of a quantitative model, existing knowledge was syntehsized into a conceptual model consistent with established physicochemical principles and the bulk of information available. (Lantz-PTT)
W89-05746

BIOLOGICAL AND CHEMICAL ASSESSMENT OF M-AREA PROCESS DISCHARGE TO TIM'S BRANCH JUNE 1985 - DECEMBER 1986,
Savannah River Ecology Lab., Aiken, SC.
W. L. Specht, J. B. Pickett, C. F. Muska, W. M. Starkel, and M. Giffin.
Available from the National Technical Information Service, Springfield, VA 22161, as DE877-014438. Price codes: A10 in paper copy, A01 in microfiche. 125p, 40 fig, 53 tab, 53 ref, 10 append. DOE Contract DE-AC09-76SR00001.

Descriptors: *Water pollution effects, *Industrial wastewater, *South Carolina, *Savannah River Plant, Radioactive wastes, *Environmental impact, Periphyton, Macroinvertebrates, Ecological effects, Toxicity, Nitrates, Nitrites, Alkalinity, Zinc, Uranium, Trichloroethylene, Biological studies, Chemical analysis, Tim's Branch.

This study addresses the effects of the A-014 outfall of the M-Area Liquid Effluent Treatment Facility (LETF) at the Savannanh River Plant, South Carolina, on the chemistry and biota of Tims Branch and Upper Three Runs Creek from June 1985 through December 1986, In addition to monthly analyses for chemical parameters, the periphyton and macroinvertebrate communities of each site were sampled monthly to assess the impact of the M-Area discharges on the overall condition of these communities. Conclusions from this study include: (1) The M-Area A-014 discharges appeared to improve the biological environment at the sample location immediately below the confluence of the A-014 discharge and Tim's Branch (TB-1) versus the conditions prior to the start of the LETF and air stripper discharges; (2) Total macroinvertebrate biomass and density was not significantly different at any Tim's Branch sample location; (3) The only significant changes in functional feeding group densities were increased in collector-filterer and scraper densities at site TB-1; (4) A comparison of the major taxa indicated a significant increase in Tanytarsini, Orthocladiinae, and Dipteran densities at site TB-1, and an increase in the density of Tanytarsini at TB-3; (5) Nitrate levels in Tim's Branch increased from < 1 mg/L to about 5 to 7 mg/L at TB-1 after effluent from the Project Air Stripper (PAS) was consistently discharged to the A014 outfall; (6) Those chemical parameters which were detected in Tim's Branch or at the A-014 outfall at concentrations greater than the upstream reference locations were nitrate, nitrite, alkalinity, specific conductance, Zn, U, and trichloroethylene. Overall, the data indicate no adverse impact on the water chemistry, water quality, or aquatic communities of the Tim's Branch/Upper Three Runs system due to discharges from the A-014 outfall after startup of the M-Area PAS and the M-Area LETF. (Lantz-PTT)
W89-05751

MANAGEMENT SIGNIFICANCE OF BIOAVAILABLE PHOSPHORUS IN URBAN RUNOFF,
Washington Univ., Seattle. Dept. of Civil Engineering.
R. R. Horner, E. B. Welch, S. R. Butkus, and D. E. Spyridakis.
Available from National Technical Information Service, Springfield, VA 22161 as PB89-101950/AS, price codes: A05 in paper copy A05, A01 in microfich. Project Completion Report, June, 1987. 82 p, 19 fig, 1 tab, 44 ref, 4 append. Contract 14-08-0001-G1259. Project USGS G-1259-04.

Descriptors: *Phosphorus, *Urban runoff, *Water pollution effects, Biologically available phosphorus, Storm runoff, Water quality, Nonpoint pollution sources, Lake trophic state, Eutrophication, Lake management, Washington, Lake Sammamish, Issaquah Creek, Algal growth, Bioassay.

Biologically available phosphorus (BAP) was determined in Lake Sammamish at two depths and in its main tributary, Issaquah Creek, by an algal growth potential bioassay technique. BAP was more closely related to soluble reactive phosphorus (SRP) than to total phosphorus. Relationships between BAP and SRP plus sodium hydroxide-extractable phosphorus were derived to permit BAP estimation from chemical measurements in the future. A previously developed nonsteady-state, mass balance model for Lake Sammamish was reformulated in terms of BAP, calibrated, and verified. A linear relationship was also derived to predict phytoplankton biomass as chlorophyll a and Secchi depth transparancy for future cases of watershed development and storm runoff pollution control. Significant change in trophic state indicators is expected without controls, while state-of-the-art retention facilities, vegetated overland flow treatment, and soil infiltration of runoff could maintain the current state. The analysis led to the generation of a series of management strategies to protect Lake Sammamish water quality. (USGS)
W89-05782

5D. Waste Treatment Processes

SLUDGE TREATMENT AND DISPOSAL IN A TROPICAL ENVIRONMENT,
RCP and Associates, Rio Piedras, PR.
For primary bibliographic entry see Field 5E.
W89-04677

PROCESS DYNAMICS OF COMPOSTING: A PROPOSED STUDY,
Puerto Rico Univ., Mayaguez. Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5E.
W89-04682

MODIFICATION OF WATER QUALITY IN IVUJIVIK (NORTHERN QUEBEC, CANADA),
Quebec Univ., Montreal.
M. Barraja, and P. DiPizzo.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu, Finland, 6-8 June 1988. Vol. 1. The Academy of Finland, Helsinki, Finland. 1988. p 232-238, 5 fig, 26 ref.

Descriptors: *Solid waste disposal, *Domestic wastes, *Canada, *Water quality management, *Drinking water supply, Public health, Sanitation, Wastewater disposal, Water pollution prevention, Waste management.

The community of Ivujivik located at the 63rd parallel is the northern-most community in Quebec. The natural conditions are severe and compulsive. The human and social economic conditions are very hard due to a change from nomad autosufficient life based on hunting and fishing to a sedentary economy based on consumption of the products from the south. This change of life-style brings acute sanitary and environmental problems due to deficient sanitary structure and to solid waste management in this northern environment. The drinking water supply is provided by tank trucks. The houses are not very well isolated, and have no plumbing or main sanitary drainage net. The wastewaters are thrown outside the houses, and solid wastes are disposed of in plastic bags that accumulate in open dumps outside the village on the shore. To improve the basic sanitary conditions, it is very important to install a plumbing system with water distribution by gravity and supplied by the existing system of delivery by trucks. The transfer to the point of supply for the drinkable water will permit a long term supply of good water quality. The installation of retention tanks with periodical emptying in each house will allow vacuum trucks to deliver wastewater to a treatment plant. The movement of the dump site is imperative for health reasons and the dumping should be controlled and landfilled. (See also W89-04689) (Author's abstract)
W89-04720

TOXICITY REDUCTION EVALUATIONS IN MUNICIPAL WASTEWATER TREATMENT PLANTS,
Environmental Protection Agency, Cincinnati, OH. Water Engineering Research Lab.
For primary bibliographic entry see Field 5A.
W89-04748

AUTOMATED DIRECT MEASUREMENTS OF TOTAL CYANIDE SPECIES AND THIOCYANATE IN PRESENCE OF EACH OTHER,
Metropolitan Sanitary District of Greater Chicago, IL.
For primary bibliographic entry see Field 5A.
W89-04784

USE OF RESPIROMETRY FOR OPERATING ACTIVATED SLUDGE PLANTS TREATING TOXIC WASTEWATERS,
Bioprocess Engineering, Inc., Wilmington, DE.
R. J. Colvin, and A. F. Rozich.
IN: Analytical Techniques and Residuals Management in Water Pollution Control Specialty Conference April 19-20, 1988. Water Pollution Control Federation, Alexandria, VA 22314-1994. p 49-60, 3 fig, 10 ref, append.

Descriptors: *Wastewater treatment, *Activated sludge process, *Process control, Respirometry, Biodegradation, Biomass, Model studies, Critical point curves, Graphical analysis, Dilute-out curves, Optimization.

A methodology is presented that can be used to apply respirometric techniques to devise specific operational guidelines for activated sludge systems. Basically, respirometry tests are performed using the target waste and plant biomass. Analysis of these results yields parameters that quantify the biodegradative capability and/or capacity of the system. These parameters then are inserted into process control models for the activated sludge system. The results of these analyses produce dilute-out curves and, if the waste is inhibitory, critical point curves. These graphs can be used to identify specific operating strategies that can be implemented to avoid permit violations and allow management to be proactive in process control and responsive to changing influent conditions or loadings. Critical point curves identify an operating condition that must not be violated. In the case of treatment of inhibitory waste, the dilute-out curves are then used to identify the overall operating range of the reactor and to provide operational guidance for process optimization. (See also W89-04782) (Rochester-PTT)
W89-04788

APPLICATION OF COMPUTERIZED QUALITY CONTROL CHARTS AND REPORTS FOR WASTEWATER FACILITIES,
Data Stream Systems, Greenville, SC.
L. G. Blackwell.
IN: Analytical Techniques and Residuals Management in Water Pollution Control Specialty Conference April 19-20, 1988. Water Pollution Control Federation, Alexandria, VA 22314-1994. 32p, 21 fig, 6 tab, 4 ref.

Descriptors: *Quality control, *Wastewater facilities, *Statistics, *Performance evaluation, Aeration, Charts, Precision, Accuracy, Cost repayment, Probability plots.

Computer development of traditional quality control (QC) charts for wastewater treatment facilities is presented. Applications for the State of California demonstrated the methodology and generated time savings of a man-week for an annual QC report. One utility demonstrated a payback from aeration system savings in less than two months. Relative accuracy and precision plots allowed a quick assessment of data that exceeded QC guidelines. Shewhart limits, standard deviation, previous plant QC data and Standard Methods provided guidelines for acceptable performance. Relative accuracy and precision graphs allowed users to assess limit exceedances quickly regardless of data count. Probability plots presented a simple and consistent method for comparing the range and dispersion of two (or more) different data bases on a single graph. In an industrial pretreatment program the wastewater treatment plant can compare internal precision and accuracy with industrial discharger analyses, providing quantitative information on data reliability. The application of plus or minus two and three standard deviation limits to process information, e.g., system aeration requirements, defines a specific basis for determining when variables are inside or outside of critical limitis. Excursions outside of these plant developed limits should trigger immediate action to determin the causative agent. (See also W89-04782) (Author's abstract)
W89-04791

CITY OF NASHVILLE COMPOSTING OPERATIONS,
E and A Environmental Consultants, Inc., Stoughton, MA.
E. Epstein, B. L. Hazelwood, and V. W. Frye.
IN: Analytical Techniques and Residuals Management in Water Pollution Control Specialty Conference April 19-20, 1988. Water Pollution Control Federation, Alexandria, VA 22314-1994. p 2-6, 2

ref.

Descriptors: *Composting, *Wastewater treatment, *Sludge disposal, *Nashville, *Tennessee, Performance evaluation, Sludge drying, Cost analysis, Filtration.

The Central composting operation of the Nashville, Tennessee, wastewater treatment department which treats 40 dry tons/day of dewatered, belt filter press sludge and the Dry Creek operation, which processes approx 8 dry tons/day of vacuum filtered sludge are described. The Dry Creek system was patterned after the Camden, New Jersey, Composting Facility, however operations were unsuccessful and therefore discontinued. Subsequent analysis showed that the failure was due to inadequate aeration capacity, inability to regulate aeration rates on individual piles, poor mixing, no curing or storage area, poor screen system, lack of operator training and operations and maintenance manuals, and sludge solids too low (14-15%) resulting in excessive use of bulking agent. This was replaced by the aerated static pile method of composting. Sludge and woodchips were mixed, an aeration plenum was laid down, a mixture of sludge and woodchips were placed over the plenum, and the pile was covered with compost. Because of the 17% sludge solids content, dewatering operations were improved by adding belt filter presses. This mechanized static pile system is expected to be able to process 40 dry tons/day when completed. Composting the sewage sludge has been shown to be an economical and environmentally acceptable sludge disposal method. (See also W89-04782) (Rochester-PTT)
W89-04795

CITY OF AUSTIN SLUDGE REUSE PROGRAM,
Camp, Dresser and McKee, Inc., Austin, TX.
For primary bibliographic entry see Field 5E.
W89-04796

FULL SCALE PILOT RESULTS: COMPOSTING WASTEWATER SLUDGES USING AGITATED-BED SYSTEM,
International Process Systems, Inc., Lebanon, CT.
G. A. Kuter, L. Naylor, and P. Gormsen.
IN: Analytical Techniques and Residuals Management in Water Pollution Control Specialty Conference April 19-20, 1988. Water Pollution Control Federation, Alexandria, VA 22314-1994. 19p, 4 fig, 9 tab, 4 ref.

Descriptors: *Composting, *Wastewater treatment, *Sludge disposal, Connecticut, Pilot plants, Performance evaluation, Sludge drying, In-vessel composting, Sludge solids, Sludge properties.

Studies performed to document the composting of municipal wastewater sludges in a vessel system are described. Pilot studies were conducted at Lebanon, Connecticut, using a forced air, agitated bed, vessel system consisting of four rectangular concrete bays 6 ft wide x 6 ft deep x 180 ft long. A total of 131 wet tons of wastewater sludge from five towns was delivered to the facility for composting. The sludges varied considerably in terms of volatile solids (68-83%), pH (5.6-7.3), and total N content (5.6-9.2%). Sawdust was used as a bulking agent for 118 tons of sludge and a mixture of leaves and chips was used for another 12.6 tons. In another study, laboratory data were obtained using Zimpro sludge and compared with the results of the pilot tests. The results with the Zimpro sludge were similar to those observed with the other sludges. Weight losses observed during the composting process were a function of both moisture loss and destruction of volatile solids. When the dryness of the input mix was maintained above 36% dry solids (ideally 40%), dry output compost (60% dry solids or greater) can be expected, with a retention time of 20-24 days. The daily mixing of the compost by agitation machinery is a unique feature of this system and appears to be an important feature facilitating the composting process. Results of the demonstration indicate that between 2.5 and 3.6 wet tons of sludge (0.6 dry tons) were processed daily in a single bay. These results were obtained with sludges at a mean of 17% dry solids; great quantities can be processed if the dry solids percentage is higher or if a drier bulking agent is used. (See also W89-04782) (Rochester-PTT)
W89-04797

AKRON SLUDGE COMPOSTING FACILITY,
Akron Composting Facility, OH.
E. Exley.
IN: Analytical Techniques and Residuals Management in Water Pollution Control Specialty Conference April 19-20, 1988. Water Pollution Control Federation, Alexandria, VA 22314-1994. p 15-20, append.

Descriptors: *Composting, *Wastewater treatment, *Sludge disposal, *Akron, *Ohio, Performance evaluation, Sludge drying, Odors, In-vessel composting, Filtration, Temperature, Fertilizers, Soil amendments, Design criteria, Heavy metals.

The Akron, Ohio, sludge composting facility was recently nominated for a national civil engineering award. The integrated design including dewatering, mixing, in-vessel composting, and material handling will lead the industry in future composting facilities and a solution to sewage sludge solids disposal. The Akron plant is designed to process 73 dry tons of sewage sludge per day. The input sludge is a mixture of gravity thickened and waste-activated diffused air flotation secondary sewage sludge. The ratio of primary sludge in the mixture ranges from 40-60% and the solids portion of the mixed sludge ranges from 4-6%. Belt filter presses dewater the sewage sludge to a cake consisting of 22-28% solids; capture rate of the presses varies from 94-97%. The compost is blended with 1.0 part sewage sludge, 2.0 parts recycle compost, 0.4 parts hardwood bark, and 0.4 parts sawdust. This blend enters the reactor with 42% dry solids and after 21 days of composting is discharged at 55-65% solids. Four reactors 20 feet wide x 10 feet deep x 726 feet long are used. Discharged compost cures for 90 days before it is sold. The major problem of the facility has been maintaining aeration to obtain proper temperature and control odors. The sludge product is a desirable product for use with ornamental plants, but Akron sludge is not recommended for agricultural use due to its high content of Cd and other metals. (See also W89-04782) (Rochester-PTT)
W89-04798

HAMPTON ROADS SANITATION DISTRICT'S COMPOST MARKETING PROGRAM,
Hampton Roads Sanitation District, Norfolk, VA.
For primary bibliographic entry see Field 5E.
W89-04799

NATIONWIDE SURVEY OF COMPOSTING FACILITIES,
BioCycle, Emmaus, PA.
N. Goldstein.
IN: Analytical Techniques and Residuals Management in Water Pollution Control Specialty Conference April 19-20, 1988. Water Pollution Control Federation, Alexandria, VA 22314-1994. p 30-36.

Descriptors: *Composting, *Surveys, *United States, *Performance evaluation, Design criteria, Cost analysis, Odors, Pricing, Economic aspects, Wastewater facilities, Technology.

BioCycle magazine conducted an annual survey of sludge composting in 1987. There were 107 operating sludge composting facilities in the United States with an additional 90 in the consideration, planning, design, or construction stages. The four most common methods for composting sewage sludge are aerated static pile, windrow, aerated windrow, and in-vessel; several plants have vermicomposting operations, using earthworms to further process the compost material. Rising interest in composting among cities is coinciding with increasing sophistication in the technology and level of operational knowledge. Odors are the number one problem being experienced by sludge composting operations thus odor control receives the most research support. Complete data on operating costs and compost production are difficult to obtain. A sampling from the questionnaires shows operating costs at static pile facilities ranging from $6 to $50/wet ton. The in-vessel facilities showed costs in the $25 to $45/wet ton range. The price of the finished compost ranges from $4-6/ cu yd. Several new ideas are emerging in the field, including: use of regional facilities to compost sludge from several towns, composting sludge with leaves, yard waste, tree trimmings, and the heavy organic fraction of the solid waste stream, plus regulatory demands that all facilities be enclosed. (See also W89-0484782) (Rochester-PTT)
W89-04800

MASSACHUSETTS WATER RESOURCES AUTHORITY: INTERIM SLUDGE MANAGEMENT PROGRAM,
Massachusetts Water Resources Authority, Boston, MA. Residuals Management Program.
For primary bibliographic entry see Field 5E.
W89-04802

MILWAUKEE'S SLUDGE REUSE PROGRAM: A DECADE OF GROWTH AND SUCCESS,
Milwaukee Metropolitan Sewerage District, WI.
For primary bibliographic entry see Field 5E.
W89-04803

CLAYTON COUNTY'S SLUDGE MANAGEMENT FACILITIES,
Clayton County Water Authority, Morrow, GA.
N. Wellons, W. S. Elliott, and J. Brandon.
IN: Analytical Techniques and Residuals Management in Water Pollution Control Specialty Conference April 19-20, 1988. Water Pollution Control Federation, Alexandria, VA 22314-1994. p 75-80, 2 tab.

Descriptors: *Sludge disposal, *Wastewater treatment, *Clayton County, *Land application, *Composting, *Georgia, Spray irrigation, Forestry, Activated sludge, Disinfection, Pelletizing, Economic aspects.

Clayton County, just south of Atlanta, Georgia, operates four treatment plants discharging, respectively, 15, 4.5, 1.1, and 4.0 MGD of treated effluent. In Clayton County, wastewater undergoes activated sludge treatment and disinfection at two of the plants, is renovated as it flows through a forested spray irrigation facility over a period of about 60 days, and then mixes with natural water sources before it is finally treated at a modern water filter plant for use as potable water. Trees from the spray irrigation facility are recycled as wood chips for fuel at the pelletizing facility or as sawdust as the carbon source for the compost facility. High quality sludge pellets and compost return organic material and nutrients to the soil. Experience with both pelletizing and enclosed vessel composting of activated sludge indicates that both are workable methods for all-weather processing of solids even though capital costs are high in each. Both systems have performed well, allowing Clayton County's plants to meet discharge standards with ease. (See also W89-04782) (Rochester-PTT)
W89-04804

EMERGING SLUDGE MANAGEMENT TECHNOLOGIES,
Tulane Univ., New Orleans, LA. Dept. of Environmental Health Sciences.
R. S. Reimers, and T. G. Akers.
IN: Analytical Techniques and Residuals Management in Water Pollution Control Specialty Conference April 19-20, 1988. Water Pollution Control Federation, Alexandria, VA 22314-1994. p 81-110, 6 tab, 45 ref.

Descriptors: *Sludge conditioning, *Sludge digestion, *Wastewater treatment, *Technology transfer, *Disinfection, Sludge dewatering, Lagoons, Electrolysis, Sludge thickening, Ozonation, Chemical fixation, Acoustics, Waste recovery, Biodegradation, Irradiation.

The current situation in sludge treatment technologies is summarized, including definitions of various processes, rationale for sludge treatment, and

characteristics of emerging technologies. Emerging and developing sludge treatment processes considered include: conditioning with organic polymers, electroacoustic dewatering, electrolytic thickening, detoxification by aerobic thermophilic digestion, use of chelating agents to enhance aerobic digestion, fixed-film digestion systems, earthworm conversion technology, molten salt combustion, fluidized bed incineration, solar drying, flash drying technology, co-combustion, oil recovery from primary sludge, hydrogen peroxide with ultrasound, fixation, solvent and metals recovery, drying beds, sludge lagoon storage, combined processes, lime stabilization, N-Viro process, chemifixation, ozonics, Modar process, plasma arc, beta irradiation, gamma irradiation, microwave irradiation, high-gradient magnetic metal separation, microbial and genetic disinfection methods, applied field (non-ionizing) irradiation, enzymes, and intense plasma treatment. Public opinion demands that municipal sludges be processed so as to be reusable. This mandate has given impetus to the need for developing innovative approaches for sludge treatment based on the possible end uses and recycling modes. The treatment of municipal sludges by innovative technologies has advanced tremendously in the last decade. While most of the innovative approaches have been simple modifications resulting in increased efficiencies and cost effectiveness of existing processes, some truly new treatment processes have evolved. The use of biotechnology, catalysts, and applied fields are examples of the latest approaches to developing economically feasible treatment methods for altering or eliminating persistent constituents to increase the recycling potential of the treated sludges. (See also W89-04782) (Rochester-PTT)
W89-04805

ALKALINE STABILIZATION AND DISINFECTION OF MUNICIPAL WASTEWATER SLUDGE IN TOLEDO, OHIO: A CASE OF GOVERNMENTAL, BUSINESS AND ACADEMIC COOPERATION,
Medical Coll. of Ohio at Toledo. Dept. of Microbiology.
J. C. Burnham.
IN: Analytical Techniques and Residuals Management in Water Pollution Control Specialty Conference April 19-20, 1988. Water Pollution Control Federation, Alexandria, VA 22314-1994. p 111-123, 4 fig, 3 tab, 5 ref.

Descriptors: *Sludge stabilization, *Wastewater treatment, *Cement kiln dust, Lime, Odor control, Disinfection, Salmonella, Coliforms, Ascaris, Viruses, Michigan, Ohio, Heat treatment, Mixing, Bioindicators.

A series of experiments were performed to examine the interaction of cement kiln dust (CKD) and lime with municipal wastewater sludge cake in relation to microorganism survival and odor to determine the effectiveness of CKD or lime in killing pollution indicator bacteria, ie, fecal coliforms and fecal streptococci, and actual pathogens (Salmonella typhimurium, poliovirus, or Ascaris suum eggs). CKD treatment of Toledo, Ohio, sludge in a pilot study was most effective at 35% CKD, leading to reduction of all organisms to acceptable levels and a reduction in odor. In a large-scale trial, 35% CKD was mixed with sludge from Monroe, Michigan, which was then windrowed outdoors, including mixing by a 'Brown Bear' mixing machine. Salmonella levels decreased from 104 colony-forming units (CFU)/5 gram dry weight sludge (gdws) to less than 1 CFU/5 gdws in 1 day. Similarly fecal coliforms were reduced from 9 million to 80 in 1 day and to < 1 per 5/gdws at 7 days. Because there was neither Ascaris nor enterovirus even in the raw sludge, further trials were needed. In treating sludge from other cities, Ascaris egg viability was reduced to less than 1/5 gdws and odor was good. Another alternative tested was lime + CKD + heat; this approach reduced the total sludge processing time from weeks to 1 day for microbial control and 7 days for good odor control. (See also W89-04782) (Rochester-PTT)
W89-04806

SIDE-BY-SIDE SLUDGE DEWATERING PERFORMANCE WITH FULL SCALE BELT FILTER PRESSES,
Memphis Wastetreatment Facilities, TN.
J. R. Collins.
IN: Analytical Techniques and Residuals Management in Water Pollution Control Specialty Conference April 19-20, 1988. Water Pollution Control Federation, Alexandria, VA 22314-1994. p 124-141, 5 tab.

Descriptors: *Wastewater facilities, *Sludge drying, *Belt filter presses, *Comparison studies, *Performance evaluation, *Memphis, *Tennessee, Cost analysis, Polymers, Wastewater treatment.

Data gathered by the Memphis Treatment plants on the productivity, cake solids, polymer usage, reliability, screen life, and life cycle costs in relation to five types of filter presses are summarized. From this experience several conclusions could be drawn. Sludge throughput with Memphis sludges varies according to the type of 2-m press both in overall throughput capability and throughput capability per effective meter of width. The combined length of the gravity section and gradual pressure (wedge) zone is likely a major influencing factor on throughput capability per effective meter of width. Effective width varies considerably among belt filter presses with nominal 2.0- or 2.2-m widths. Sludge throughput on a belt filter press varies substantially with the solids in the sludge being dewatered. On Memphis sludges throughput varies directly with the feed sludge solids concentration and inversely with the percent volatile portion of the feed sludge solids. The data collected on the four types of Belt Filter Presses at the Memphis North Plant suggests that some difference between the degree of cake dryness may be obtained by similar types of belt filter presses. The type of belt filter press has little or no effect on polymer dosage requirements. Polymer use depends instead on the type of sludge being dewatered. There can be a substantial difference among various types of belt filter presses in terms of mechanical reliability. Insofar as the various presses operated by the City of Memphis are concerned, no obvious significant economic advantage was apparent in using an endless woven polyester belt or a Spiral-Link belt versus a woven polyester belt with a clipper seam. Among the four belt filter presses used at the North Plant, there is no significant advantage of one over the others in terms of solids capture. The task of determining which type or types of belt filter presses will represent the lowest life cycle cost is best left to the individual municipality or industry. (See also W89-04782) (Rochester-PTT)
W89-04807

CITY OF TAMPA SLUDGE PELLETIZING PROJECT,
Hookers Point Advanced Wastewater Treatment Plant, Tampa, FL.
D. W. Pickard, J. E. Drapp, and T. W. Burke.
IN: Analytical Techniques and Residuals Management in Water Pollution Control Specialty Conference April 19-20, 1988. Water Pollution Control Federation, Alexandria, VA 22314-1994. p 142-152, 5 fig.

Descriptors: *Sludge utilization, *Sludge conditioning, *Pelletizing, *Wastewater treatment, *Tampa, *Florida, Performance evaluation, Design criteria, Odors, Comparison studies, Pilot plants.

The City of Tampa, Florida, operates a 60-mgd advanced wastewater treatment plant that produces an average of 32 dry tons of sludge daily. Future sludge yields of 45-63 dry tons/day have been projected. Specific problems of existing sludge pelletizing plants were addressed in a design study. These are: (1) offensive odors from the processing train exhaust air; (2) product quality, sizing, and uniformity; (3) evaporation rates; (4) materials handling; and (5) fuel costs and heat exchange difficulties. Mass and energy balance diagrams are presented here for the three preliminary designs for the Tampa plant and the overall site plan and plant layout for the chosen version are included. The alternative chosen was selected because of its fuel efficiency and the prospect of more effective odor control resulting from the use of an afterburner. In addition, the chosen alternative also allows the use of waste heat from an external heat source, as well as a direct-fueled gas burner. The plant also includes a screening step. The equipment should be able to process 31.5 tons/day in each of two processing trains. A test using Tampa sludge at another city where a plant similar to the new design already existed showed that the Tampa sludge could be processed into a saleable pelletized product, with adequate odor control for building air. However, afterburners were more effective for odor control for process air. (See also W89-04782) (Rochester-PTT)
W89-04808

SEWAGE SLUDGE REUSE/DISPOSAL IN AN EVOLVING REGULATORY ATMOSPHERE: A CALIFORNIA PERSPECTIVE,
Carollo (John) Engineers, Walnut Creek, CA.
For primary bibliographic entry see Field 5E.
W89-04809

BIOREMEDIATION OF CONTAMINATED SOILS,
Texas Univ. at Austin. Dept. of Civil Engineering.
R. C. Loehr, and R. M. Kabrick.
IN: Analytical Techniques and Residuals Management in Water Pollution Control Specialty Conference April 19-20, 1988. Water Pollution Control Federation, Alexandria, VA 22314-1994. p 165-175, 1 fig, 3 tab, 3 ref.

Descriptors: *Bioremediation, *Biological treatment, *Water pollution treatment, *Hazardous materials, *Biodegradation, Toxicity, Industrial wastes, Sludge, Soil contamination, On-site treatment, Cleanup operations, Microorganisms.

Bioremediation is a managed, demonstrated active treatment process that uses microorganisms to degrade and transform the chemicals in contaminated soil and industrial sludges and residues. The process also reduces the toxicity of the organics and the migration potential of hazardous constituents in such material. On-site and in-situ bioremediation process have been used for the treatment of residues from the petroleum and wood preserving industries and for soils contaminated by contents of lagoons and storage impoundments. The fundamentals of biological treatment, as applied to these methods to achieve cleanup, closure, and treatment objectives, are the key to the proper design and operation of bioremediation processes. Treatability evaluations determine the technical and economic feasibility of alternative process configurations. Such evaluations include (1) waste and residue characterization, (2) problem and performance definition, (3) controlled laboratory studies, (4) pilot and/or field studies, and (5) large-scale demonstrations. Case studies described here and other examples indicate that bioremediation is a feasible method for the degradation or organics in contaminated soils and in residues from industrial processes. It is possible to use naturally occurring microorganisms and to enhance their activity by modifying and controlling their environment. Specially developed microorganisms have not be shown to be necessary. (See also W89-04782) (Author's abstract)
W89-04810

REGIONAL SEPTAGE DISPOSAL IN SOUTHEASTERN CONNECTICUT,
Norwich Dept. of Public Utilities, CT.
For primary bibliographic entry see Field 5E.
W89-04811

CASE STUDY OF AGRONOMIC LAND APPLICATION OF SLUDGE,
Black and Veatch, Inc., Cambridge, MA.
For primary bibliographic entry see Field 5E.
W89-04813

LAND APPLICATION OF INCINERATOR ASH,

Minnesota Univ., St. Paul. Dept. of Soil Science.
For primary bibliographic entry see Field 5E.
W89-04814

LAND APPLICATION OF KODAK COLORADO DIVISION WASTEWATER TREATMENT PLANT SLUDGE,
Eastman Kodak Co., Windsor, CO. Kodak Colorado Div.
For primary bibliographic entry see Field 5E.
W89-04815

BIOLOGICAL TREATMENT OF TOXICS IN WASTEWATER: THE PROBLEMS AND OPPORTUNITIES,
Environmental Protection Agency, Cincinnati, OH. Water Engineering Research Lab.
D. F. Bishop, and N. A. Jaworski.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-124094. Price codes: A03 in paper copy, A01 in microfiche. Report No. EPA/600/D-87/326, October 1987. 28p, 3 fig, 7 tab, 33 ref.

Descriptors: *Biological wastewater treatment, *Toxic wastes, *Wastewater treatment, *Toxicity, Water pollution control, Separation technology, Volatilization, Biodegradation, Anaerobic treatment, Anaerobic digestion.

EPA research on toxics control in wastewater treatment involves three approaches: (1) specific toxics treatability to determine the respective contribution of the three removal mechanisms in conventional wastewater treatment; (2) toxicity degradation and reduction in treatment and pretreatment; and (3) innovative concepts to enhance control of toxics in biological treatment. The goal of the treatability research is to develop predictive procedures to estimate the fate of specific toxics in conventional wastewater treatment. Progress in developing the data on the removal mechanisms of partitioning, volatilization and biodegradation is described. Toxicity reduction evaluation (TRE) studies are being used to isolate and trace the causes of toxicity pass-through in treatment, to identify the specific toxics, and to evaluate treatment and pretreatment approaches to reduce toxicity pass-through. Innovative concepts to enhance toxic control include control of the toxic discharge rates into treatment; use of additives such as clays, binding proteins, carbons, enzymes, etc.; use of anaerobic-aerobic treatment combinations, use of bioengineered organisms, and the use of special reactors and operational approaches at central treatment plants to improve toxics removals. (Author's abstract)
W89-04839

REMOVAL OF CHROMIUM FROM ION EXCHANGE REGENERANT SOLUTION,
Houston, TX.
For primary bibliographic entry see Field 5F.
W89-04841

ANAEROBIC FLUID-BED TREATMENT OF COAL CONVERSION WASTEWATER,
Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.
M. T. Suidan, J. T. Pfeffer, G. F. Nakhalm, and U. K. Traegner.
Available from the National Technical Information Service, Springfield, VA 22161, as DE88-000628. Price codes: A03 in paper copy, A01 in microfiche. Report No. DOE/PC/90514--T4. Fourth Quarterly Technical Progress Report for the period MAy 15 to August 15, 1987. 16p, 7 fig, 2 tab. DOE Contract DE-FG22-86PC90514.

Descriptors: *Coal wastes, *Costs, *Anaerobic digestion, *Fluidized beds, *Wastewater treatment, Activated carbon, Adsorption, Mathematical models, Industrial wastewater.

Anaerobic fluidized-bed granular activated carbon (GAC) reactors have proven successful for the treatment of biologically inhibiting wastewaters such as coal conversion wastewater. However, in treating such wastewaters which contain compounds that not only resist biodegradation but also inhibit the degradation of other compounds, adsorption on GAC is a viable strategy for the removal of these inhibitory compounds. Since the adsorptive capacity of the reactor media is limited, partial replacement of the carbon bed is necessary to maintain the concentration of inhibitory compounds below threshold levels. The cost of the GAC replacement thus represents a major operating cost of the system. The hydraulic detention time and the associated carbon inventory represent the single most important capital cost parameter. The objectives of this research were to determine, using experimental and modeling strategies, the effects of hydraulic detention time and the schedule of GAC replacement on the performance of fluidized bed GAC anaerobic reactors during the treatment of coal conversion wastewater. This objective was realized by the following activities: (a) Operation of two expanded-bed GAC anaerobic reactors at empty-bed hydraulic detention times of 1.0 and 0.5 days; (2) Development of a mathematical model of the expanded-bed GAC anaerobic reactor incorporating the various interactions that occur in this process such as biodegradation, adsorption on GAC, and the regular replacement of reactor GAC with virgin media; and (3) Use of the calibrated model to analyze a vast volume of experimental data on the treatment of coal gasification wastewater and refinery sour stripper bottoms using fluidized bed GAC anaerobic reactors that have already been collected. (Lantz-PTT)
W89-04843

PHYSICAL, CHEMICAL, AND TOXICOLOGICAL CHARACTERIZATION OF UNTREATED AND TREATED TAR SAND WASTEWATERS,
University of Wyoming Research Corp., Laramie. Western Research Inst.
W. F. McTernan, S. L. Hill, and W. E. Blanton.
Available from the National Technical Information Service, Springfield, VA 22161, as DE88-000292. Price codes: A03 in paper copy, A01 in microfiche. Report No. DOE/FE/60177--2431, April 1985. 34p, 8 fig, 10 tab, 18 ref. DOE Contract DE-FC21-83FE60177.

Descriptors: *Wastewater treatment, *Chemical analysis, *Toxicity, *Tar sands, Ferric chloride, Coagulation, Flotation, Polymers, Activated carbon, Adsorption, Physical properties.

A study was conducted to evaluate the effectiveness of four treatment processes for reducing the contaminant load and toxicity of TS-1S wastewater generated during an in situ steam flood. The treatment processes included: (1) ferric chloride coagulation; (2) ferric chloride coagulation plus activated carbon adsorption; (3) polymer-assisted flotation, and (4) polymer-assisted flotation plus activated carbon adsorption. According to the results of chemical analyses, the effluents generated by these treatment processes were very similar. However, polymer-assisted flotation plus activated carbon adsorption was most effective for reducing toxicity, whereas ferric chloride coagulation appeared to increase toxicity to at least one of the organisms tested. Thus, standard physicochemical analyses were not adequate indicators of the potential environmental hazards of TS-1S wastewater, as determined by toxicity testing. This study indicated that physical, chemical, and toxicological characterization is necessary to fully assess the potential environmental hazards of tar sand waters or any other chemically complex water. The study also expanded the data base for tar sand wastewaters. Compared with TS-1S wastewater, samples produced in the laboratory by steam displacement contained low concentrations of total organic carbon and total suspended solids, whereas samples produced by reverse combustion were relatively acidic and contained high concentrations of total organic carbon. (Lantz-PTT)
W89-04844

MUNICIPAL SLUDGE MANAGEMENT PLANNING AND POLICY OPTIONS,
E and A Environmental Consultants, Inc., Stoughton, MA.
E. Epstein, and J. Alpert.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-160510. Price codes: A10 in paper copy, A01 in microfiche. Report No. ILENR/RE-PA-87/20, November 1987. 203p, 43 fig, 45 tab, 71 ref, append. Illinois Department of Energy and Natural Resources Contract EH 4.

Descriptors: *Wastewater treatment, *Sludge disposal, *Decision making, *Municipal wastewater, *Wastewater management, Sludge, Wastewater disposal, Sludge utilization, Standards, Ilinois.

A document was prepared to introduce municipal public decision makers to the issues relating to wastewater treatment plant sludge production treatment and use/disposal. Chapter Two gives a description of basic wastewater treatment processes and how these processes affect sewage sludge quantity and quality. The chapter also explains the impact of sludge characteristics on use/disposal options. Chapter Three discusses the factors which will affect the selection of sludge-treatment alternatives. These factors are discussed in a generic way with ample references to the applicable regulations and guidelines. Interactions between technology, socio-political considerations, site requirements, and other factors which are necessary to match a sludge-treatment solution to the needs of the community are discussed. Chapter Four gives technical details on currently available sludge-treatment technologies applicable to Illinois. This chapter utilizes the information described in Chapter Three to illustrate which types of constraints there are for each of the technologies. In addition to generic descriptions of the technologies, there are case studies of Illinois communities which utilize the various sludge utilization/disposal methodologies. Chapter Five summarizes the report by walking through the sludge-management decision-making process, illustrating the information necessary to make an informed decision. It also shows flow paths through the entire process. (Author's abstract)
W89-04883

CHARACTERIZATION OF PRODUCED WATERS FROM NATURAL GAS PRODUCTION OPERATIONS. VOLUME I,
ERT, Pittsburgh, PA.
For primary bibliographic entry see Field 5A.
W89-04887

POLLUTION OF GROUND WATER BY NUTRIENTS AND FECAL COLIFORMS FROM LAKESHORE SEPTIC TANK SYSTEMS,
New York State Dept. of Health, Albany. Wadsworth Center for Labs. and Research.
For primary bibliographic entry see Field 5B.
W89-04978

BEHAVIOR OF SELECTED CHLORINATED ORGANIC MICROPOLLUTANTS IN THE ACTIVATED SLUDGE PROCESS: A PILOT PLANT STUDY,
Rentokil Ltd., East Grinstead (England). Research and Development Div.
For primary bibliographic entry see Field 5B.
W89-04979

BIOLOGICAL TREATMENT OF PHARMACEUTICAL WASTEWATER,
Indian Inst. of Tech., Bombay. Centre for Environmental Science and Engineering.
S. P. Mayabhate, S. K. Gupta, and S. G. Joshi.
Water, Air, and Soil Pollution WAPLAC, Vol. 38, No. 1-2, p 189-197, March 1988. 5 fig, 2 tab, 6 ref.

Descriptors: *Wastewater treatment, *Activated sludge process, *Biological wastewater treatment, *Industrial wastewater, Pharmaceutical wastes, Coagulation, Chemical oxygen demand, Design criteria, Phenols, Inhibition, Retention time.

A study of physicochemical and biological treatment of pharmaceutical wastewater by the activated sludge process was performed in an oxidation ditch. Based on the findings, several conclusions were made. Physicochemical treatment is not prac-

tical because the doses of coagulants required were high and the chemical oxygen demand reduction was marginal. The bench scale study performed to evaluate basic biological characteristics showed that the wastewater could be processed successfully without the inhibition of bacterial growth by phenol. The main parameters of concern are MCRT (mean cell residence time) and HRT (hydraulic retention time). In evaluating the treatability of a new process wastewater at high SRTs (greater than 10 days), it is essential that equilibrium be attained prior to the investigative period. One drawback in the data base is that the attainment of steady-state has been defined on the basis of HRT rather than MCRT. The wastewater containing high chemical oxygen demand and phenol could be treated at HRTs ranging from about 1 to 3 days with solid retention time varying from 8 to 16 days. It was possible to remove chemical oxygen demand between 86 and 91% and phenol about 50%. Recommended design criteria for pharmaceutical wastewater treatment by activated sludge in oxidation ditch are: (1) solid retention times of 8 to 16 days, (2) hydraulic residence time of about 1 to 3 days, and (3) chemical oxygen demand removal rates of 0.19 to 0.24 per day. (Miller-PTT)
W89-04992

ROLE OF AIR BUBBLES IN THE DESORPTION OF AMMONIA FROM LANDFILL LEACHATES IN HIGH PH AERATED LAGOON,
University of Strathclyde, Glasgow (Scotland). Dept. of Civil Engineering.
P. G. Smith, and F. K. Arab.
Water, Air, and Soil Pollution WAPLAC, Vol. 38, No. 3-4, p 333-343, April 1988. 6 fig, 1 tab, 10 ref.

Descriptors: *Wastewater treatment, *Ammonia, *Landfills, *Leachates, *Aerated lagoons, Air-water interfaces, Hydrogen ion concentration, Lagoons, Waste disposal.

Desorption of NH3 from wastewater in a laboratory scale aerated lagoon was investigated. Landfill leachate of around 575 mg/L NH3-N was used as the wastewater. The pH was raised to above 11.0 to achieve almost 100% conversion of NH4+ to NH3. The percentage NH3 desorbed at the free liquid surface and that desorbed into the air bubbles was quantified. Increasing the air flow rate or the container area in contact with the atmosphere increases the rate of NH3 desorption. Reactor configuration is an important variable, with inhibition of surface turbulence resulting in reduced efficiency of NH3 removal. The rate reaction coefficient, K, increases with an increase in the ratio of the container area to the atmosphere divided by liquid volume for a given air flow per unit volume. Practical observations and theoretical calculations of NH3 diffusing into air bubbles show that between 15 and 38% of the total NH3 removed is accounted for by NH3 diffusion into the air bubble. Desorption at the upper surfaces is dominant in NH3 desorption. The main role of the air bubbles is to create surface turbulence; NH3 desorption into the bubble is of secondary importance. (Miller-PTT)
W89-04998

APPLICATION OF AN EFFICIENT NONLINEAR REGRESSION TECHNIQUE FOR SEWER COST MODELLING,
National Univ. of Singapore. Dept. of Civil Engineering.
For primary bibliographic entry see Field 6B.
W89-05000

INFLUENCE OF UV RADIATION ON ORGANIC MATTER TRANSFORMATION AND SUBSEQUENT ALTERATION OF LEACHING AND TRANSPORT PROCESSES OF HEAVY METALS,
Rome Univ. (Italy). Dept. of Chemistry.
For primary bibliographic entry see Field 5B.
W89-05009

PLANT BIOMASS AND NUTRIENT LEVELS OF A TROPICAL MACROPHYTE (CYPERUS PAPYRUS L.) RECEIVING DOMESTIC WASTEWATER,
Dar es Salaam Univ. (Tanzania). Dept. of Zoology and Marine Biology.
F. M. M. Chale.
Hydrobiological Bulletin HYBUD9, Vol. 21, No. 2, p 167-170, December 1987. 1 tab, 19 ref.

Descriptors: *Land disposal, *Wastewater treatment, *Aquatic plants, *Papyrus, *Swamps, Biomass, Nutrients, Wastewater, Nitrogen, Phosphorus, Cyperus papyrus, Municipal wastewater.

The aboveground biomass and nutrient content of C. papyrus were determined in a small tropical swamp receiving domestic wastewater. The biomass (4,955 g/sq m dry wt) was the highest ever reported for papyrus. The levels of both N and P in the plant organs were very high. The N concentrations were 4.8% roots, 8.4% rhizomes, 4.5% scales, 4.8% culms, and 6.2% umbels on dry weight basis. The P concentrations were 0.09% roots, 0.11% rhizomes, 0.09% scales, 0.10% culms, and 0.13% umbels. The high biomass and nutrient contents of the plants may have been caused by the high nutrient levels in the surrounding water. Comparison of the N to P ratios in the plants to those in the surrounding water showed that the plants stored very high amounts of N. (Author's abstract)
W89-05040

BIODEGRADATION OF SUBSTITUTED BENZENES,
InterBio Labs., Dublin (Ireland).
C. Goulding, C. J. Gillen, and E. Bolton.
Journal of Applied Bacteriology JABAA4, Vol. 65, No. 1, p 1-5, July 1988. 1 fig, 2 tab, 17 ref.

Descriptors: *Aromatic compounds, *Biodegradation, *Biological wastewater treatment, *Wastewater treatment, *Benzenes, Microbiological studies, Phenols, Chlorinated hydrocarbons, Microbial degradation.

The ability of an association of micro-organisms to degrade a range of substituted aromatic compounds was assessed. The microbial blend consisted of five pseudomonads, one klebsiella, four rhodococci and two fungal strains. Chlorinated benzenes, phenols and benzoic acids were provided as sources of carbon and energy, and degradation rates monitored. The effect of the presence of other aromatic compounds such as methylated and chloromethylated aromatics, and of rapidly metabolizable substrates was also investigated. The significance of bioaugmentation of waste-treatment processes with such an inoculum is discussed. Further development of microbial inocula with the ability to degrade these groups of compounds will offer an alternative to present systems. (Author's abstract)
W89-05218

SUSPENDED SOLIDS REMOVAL IN DETENTION BASINS,
Syracuse Univ., NY. Dept. of Civil Engineering.
S. J. Nix, J. P. Heaney, and W. C. Huber.
Journal of Environmental Engineering JOEDDU, Vol. 114, No. 6, p 1331-1343, December 1988. 4 fig, 3 tab, 37 ref. EPA Project CR-805664.

Descriptors: *Wastewater treatment, *Detention reservoirs, *Suspended solids, *Desilting basins, *Urban runoff, Hydraulic engineering, Water quality control, Simulation, Design standards.

Detention basins are being used to improve the quality of stormwater discharges from urban areas. While the design of detention facilities for quantity control is fairly well understood, the same cannot be said for the design of basins to improve water quality. It appears that no theoretical arguments can be made for using design storms and steady-state assumptions to predict the suspended solids removal capability of stormwater detention basins. A more logical course would be to investigate long-term performance. This paper demonstrates an approach for estimating the long-term performance of detention basins with respect to suspended solids removal. The approach involves the simulation of detention basin behavior, and it is described and demonstrated with a hypothetical case study in which the Storm Water Management Model was used to produce performance information over large ranges of storage capacity and discharge capacity. The comprehensive information that can be generated by such a simulation gives an engineer significant guidance for the planning and design of a detention basin. (Author's abstract)
W89-05224

INTERACTION OF MASS TRANSFER AND INHIBITION IN BIOFILMS,
Utah State Univ., Logan. Dept. of Civil and Environmental Engineering.
D. K. Stevens.
Journal of Environmental Engineering JOEDDU, Vol. 114, No. 6, p 1352-1358, December 1988. 3 fig, 16 ref.

Descriptors: *Inhibition, *Biological wastewater treatment, *Biofilms, *Mass transfer, *Wastewater treatment, *Mathematical models, Biological treatment, Kinetics, Biofiltration.

Two kinetic inhibition models were considered in concert with mass transport equations in biofilm to demonstrate how these phenomena interact, and explain, in principle, why fixed-film processes may be more stable than their dispersed growth counterparts. For substrate inhibition, the reaction rate in the biofilm, at reduced concentration, can be up to 250% greater than in the bulk solution under strong inhibition. Regions of multiple solutions of the model equations were observed. In cases where product inhibition occurs, the biofilm reaction rate is always less than in the bulk solution, but the mass transfer effect is small under strong inhibition. These calculations offer a strong foundation for the enhanced stability often seen with fixed-film wastewater treatment processes. (Author's abstract)
W89-05226

ANAEROBIC BIODEGRADATION OF PHENOL: INHIBITION KINETICS AND SYSTEM STABILITY,
Illinois Univ., Urbana. Dept. of Civil Engineering.
M. T. Suidan, I. N. Najm, J. T. Pfeffer, and Y. T. Wang.
Journal of Environmental Engineering JOEDDU, Vol. 114, No. 6, p 1359-1376, December 1988. 11 fig, 2 tab, 20 ref. EPA Cooperative Agreement CR812582-01.

Descriptors: *Wastewater treatment, *Biodegradation, *Phenols, *Anaerobic digestion, *Inhibition, *Stability analysis, *Model studies, *Wastewater treatment, Microbial degradation, Kinetics, Biological treatment.

The Haldane inhibition model was used to describe the anaerobic microbial biodegradation of phenol. Experimental data on the biodegradation of phenol obtained from a continuous flow fermenter and a series of closed batch reactors were analyzed. Phenol was found to have a very low half velocity coefficient, K sub s, value of 0.03 mg/L. Other kinetic parameters included a maximum specific utilization rate, k, of 0.027/hr, a Haldane inhibition constant, K sub i, of 363 mg/L, a biomass yield factor, Y, of 0.16 mg/mg, phenol, and a biomass decay coefficient, b, of 0.0008/hr. Analytical system stability studies on the continuous flow fermenter operating at steady state were theoretically simulated using the phenol kinetic parameters. Pulse and step increases in phenol influent feed concentration were simulated and the response of the fermenter was analyzed using a computer program. Conditional and unconditional recovery regions from a pulse feed input were identified. For each influent phenol concentration of less than 1,650 mg/L, there exists a critical hydraulic detention time, Theta sub cr, above which fermenter recovery is insured for any pulse increase in the phenol feed concentration. When operated under steady state feed concentration of 4,000 mg/L phenol and a hydraulic detention time of 30 days, the anaerobic fermenter was able to recover from step increases in phenol feed concentration of up to

8,500 mg/L. Under the same steady state conditions, however, a step increase to 10,000 mg/L phenol feed concentration led to complete system failure. (Author's abstract)
W89-05227

SULFIDE-INDUCED INHIBITION OF ANAEROBIC DIGESTION,
Tennessee Univ., Knoxville. Dept. of Civil Engineering.
B. L. Hilton, and J. A. Oleszkiewicz.
Journal of Environmental Engineering JOEDDU, Vol. 114, No. 6, p 1377-1391, December 1988. 8 fig, 3 tab, 23 ref.

Descriptors: *Sulfides, *Anaerobic digestion, *Biodegradation, *Inhibition, *Wastewater treatment, *Biological treatment, Methane bacteria, Hydrogen ion concentration, Hydrogen sulfide.

Batch anaerobic digestion studies of the effects of pH and sulfide concentration upon lactose utilization, acetate utilization, and sulfate reduction using lactate as a carbon source were performed using 100 mL glass syringes. Increased concentration of un-ionized H2S inhibited lactose utilization and acetate utilization whereas total sulfide concentration, more than un-ionized H2S, inhibited sulfate reduction. Increased retention time was required to carry lactose and acetate utilization to completion in the presence of high concentrations of TS. Almost 90% utilization of lactose at undissociated H2S in excess of 900 mg/L was attained at a retention time of 228 hr. Acetate utilization was 100% complete after 74 days at 175 mg/L H2S and deteriorated rapidly to zero at higher H2S concentrations. A mechanism is proposed whereby the carbon flow can be diverted from sulfate reduction to methanogenesis in spite of the presence of a high concentration of sulfate. (Author's abstract)
W89-05228

GRAVEL PACKED BAFFLED CHANNEL FLOCCULATOR,
American Univ., Beirut (Lebanon). Dept. of Civil Engineering.
G. M. Ayoub, and F. F. Nazzal.
Journal of Environmental Engineering JOEDDU, Vol. 114, No. 6, p 1448-1463, December 1988. 10 fig, 3 tab, 18 ref.

Descriptors: *Water treatment, *Gravel packing, *Flocculation, *Wastewater treatment, *Baffles, Filtration, Pilot plants, Turbidity.

Experimental tests were conducted on a gravel packed baffled channel reactor to determine its effectiveness in promoting flocculation. The experiments included a series of laboratory tests carried out on a pilot plant in which influent flow rates, turbidity, coagulant dosages, gravel size, and channel packing length were used as variables. The results were compared to a similar study carried out on a plain baffled channel reactor. Test results indicate that the reactor is a highly efficient flocculation system. For the same channel length, Gt values attained in the gravel packed reactor were about 3 times those obtained in the plain reactor. Turbidity removal efficiencies of 95% were recorded with a possibility of higher efficiencies being attained. Equal removal values can be obtained with a gravel packed reactor that is 60% shorter than a plain reactor. Initial turbidity, coagulant dose and size of gravel were found to be directly proportional to the flocculation efficiency and the floc strength. (Author's abstract)
W89-05233

SEASONAL PATTERNS IN ACCUMULATION AND PARTITIONING OF BIOMASS AND MACRONUTRIENTS IN TYPHA SPP.,
Minnesota Univ., St. Paul. Dept. of Botany.
E. G. Garver, D. R. Dubbe, and D. C. Pratt.
Aquatic Botany AQBODS, Vol. 32, No. 1-2, p 115-127, October 1988. 4 fig, 2 tab, 31 ref.

Descriptors: *Land treatment, *Wastewater treatment, Energy production, *Seasonal variation, *Macrophytes, *Plant physiology, *Typha, *Nutrients, Biomass, Plant tissues, Bioaccumulation, Growth rates, Wetlands, Nitrogen, Phosphorus, Potassium.

Seasonal patterns of biomass and nutrient accumulation in Typha latifolia L., T. angustifolia L. and T. X glauca Godr. grown in cultivated stands in Minnesota were monitored over the course of two growing seasons and two winters. Nitrogen, phosphorus and potassium were the nutrients studied, because of their implications for commercialization of bio-energy and wastewater treatment systems. Results indicate that the biomass and nutrient accumulation are in a lag phase during the first 4-8 weeks of growth in the spring. The plants then enter a rapid growth phase in which 47-80% of the total seasonal biomass production and nutrient uptake occurs in a 4-8 week period. During this time, Typha leaves account for 60-70% of the biomass and represent the major nutrient sink. As the rate of biomass and nutrient accumulation diminishes, translocation of nutrients and photoassimilate from leaves to rhizomes occurs with an estimated 40% of leaf nitrogen, 35-44% of leaf phosphorus and 4-38% of leaf potassium translocated to the rhizomes by 27 October. Over the winter, 75% or more of the rhizome biomass, nitrogen, phosphorus and potassium is preserved. An annual fall harvest of leaf biomass would be preferred in a bio-energy production system since it is the most efficient in terms of biomass produced per unit of nutrient removed. In a wastewater treatment system, a semi-annual harvest for nutrient removal would be preferred if stand vigor can be maintained by carefully determining optimum cutting dates. (VerNooy-PTT)
W89-05258

WATER QUALITY IN THE PAWTUXET RIVER: METAL MONITORING AND GEOCHEMISTRY,
Rhode Island Univ., Narragansett. Graduate School of Oceanography.
For primary bibliographic entry see Field 5B.
W89-05269

AFTERNOON DEPRESSION IN PRIMARY PRODUCTIVITY IN A HIGH RATE OXIDATION POND (HROP),
Zurich Univ., Kilchberg (Swizerland). Hydrobiological-Limnological Station.
F. Schanz, and Z. Dubinsky.
Journal of Plankton Research JPLRD9, Vol. 10, No. 3, p 373-383, May 1988. 3 fig, 1 tab, 41 ref.

Descriptors: *Wastewater treatment, *Primary productivity, *Photosynthesis, *Oxidation ponds, *Respiration, *Diurnal variation, Laboratories, Biochemistry, Chemical properties, Ponds, Algae.

High-rate oxidation ponds (HROPs) are used to treat wastewater rich in organic substances from industrial (e.g. food production), domestic, or agricultural origin. Algae (mainly Euglena sp.) from an HROP were used for studying the afternoon depression in primary productivity. The phenomenon was observed on the same date by laboratory measurements of photosynthesis and respiration (oxygen evolution method) as well as by in situ determinations of C14 incorporation. The following values of the scope of the linear part of the curve representing the relationship between the assimilation number and light intensity were calculated: morning, 0.014 micromols O2/mg Chl a/min/micromol quanta/sq m-s; afternoon, 0.008. Assuming a constant specific light-attenuation coefficient of 0.006 sq m/mg Chl a, the quantum requirement in the morning sample was found to be considerably lower than in the afternoon sample (surface: morning 44 mol quanta/mol O2; afternoon, 71). Besides this reduction in photosynthetic efficiency, the afternoon sample also exhibited reduced light saturated photosynthetic rates and enhanced dark respiration rates. The combination of these three effects led to considerably lower areal primary productivity in the HROP in the afternoon. It is suggested that this phenomenon is brought about by carbon limitation and cell overloading by photosynthetic products. (Author's abstract)
W89-05297

EFFECT OF VARIOUS NUCLEOPHILES ON THE MUTAGENICITY OF SOFTWOOD CRAFT CHLORINATION EFFLUENT,
Kyushu Univ., Fukuoka (Japan). Dept. of Forest Products.
For primary bibliographic entry see Field 5C.
W89-05332

MATHEMATICAL MODEL OF THE CYCLONIC OPERATION OF DESALINATION-FEEDWATER SOFTENING BY ION-EXCHANGE WITH FLUIDIZED-BED REGENERATION,
California Univ., Berkeley. Dept. of Chemical Engineering.
P. Shain, G. Klein, and T. Vermeulen.
Desalination DSLNAH, Vol. 69, No. 2, p 135-146, July 1988. 3 fig, 4 tab, 12 ref.

Descriptors: *Pretreatment of wastes, *Model studies, *Wastewater treatment, *Fluidized bed process, *Desalination, *Water softening, *Ion exchange, *Farm wastes, Resins, Desalination apparatus, Mathematical equations, Calcium.

This work optimizes the steady cyclic operation of an ion-exchange pretreatment of agricultural wastewater that is fed to a desalination plant. The ion-exchange resin is exhausted to remove calcium in a fixed bed. Brine from the desalination plant regenerates the ion exchanger in a fluidized bed to prevent plugging by calcium sulfate. After the calcium sulfate precipitates, the regenerant can be reused. To predict how the plant should be operated, a mathematical model was used to describe regeneration in a continuous-flow stirred-tank reactor (CSTR). Using a FORTRAN program to solve integral equations numerically, the CSTR model was used to predict the final column compositions from the starting column compositions, and regenerant compositions and volumes. The volume of water softened was determined by local-equilibrium theory. The Gause-Seidel iteration method was used to solve the system of equations, with experimental operating conditions providing inputs for the computer program. The model qualitatively agreed with experimental results, although not completely. The most obvious reason for this is that the assumptions made to obtain the predictions, particularly the local-equilibrium theory, were not entirely realistic. Additional differences may have been caused by the use of concentrated soft water rather than synthetic brine. (Friedmann-PTT)
W89-05333

STOCHASTIC MODELS FOR FIRST-ORDER KINETICS OF BIOCHEMICAL OXYGEN DEMAND WITH RANDOM INITIAL CONDITIONS, INPUTS, AND COEFFICIENTS,
McGill Univ., Montreal (Quebec). Dept. of Civil Engineering.
R. Leduc, T. E. Unny, and E. A. McBean.
Applied Mathematical Modelling AMMODL, Vol. 12, No. 6, p 565-572, December 1988. 4 fig, 6 tab, 34 ref.

Descriptors: *Model studies, *Stochastic models, *Model studies, *Kinetics, *Biochemical oxygen demand, *Wastewater treatment, *Water pollution, Stochastic process, Oxygen demand, Differential equations, Mathematical studies.

Biochemical oxygen demand (BOD) is a parameter of prime importance in surface water pollution studies and in the design and operation of wastewater treatment plants. A general, stochastic analytical model (denoted S1) is developed for the temporal expectation and (heteroscedastic) variance of first-order BOD kinetics. The model is obtained by integrating the moment equation, which is derived from the mathematical theory of stochastic differential equations. This model takes into account random initial conditions, random inputs, and random coefficients. By constraining these three variance parameters to either vanish or to be nonnegative, model S1 is allowed to split into six stochastic 'submodels' (denoted S2 to S7), with each of these submodels being a particular case of the general model. Model S1 also degenerates to the deterministic model (denoted D) when each of

the variance parameters vanishes. The deterministic parameters (i.e., the rate coefficient and the ultimate BOD) and the stochastic variance parameters of the seven models are estimated on sets of replicated BOD data using the maximum likelihood principle. In this study, two (S5 and S7) of these seven stochastic models are found to be appropriate for BOD. The stochastic input (S5) model (i.e., null initial condition and coefficient variance parameters) shows the best prediction capabilities, while the next best is the stochastic initial condition (S7) model (i.e., null input and coefficient variance parameters). (Author's abstract)
W89-05346

TRAINING SUPPORT FOR URBAN SANITATION ACTIVITIES IN DJIBOUTI,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
D. B. Warner, and A. Prins.
Water and Sanitation for Health Project Field Report No. 200, January 1987. 55p, 6 append. AID Contract 5942-C-00-4085-00, Project 936-5942.

Descriptors: *Training, *Water treatment, *Wastewater treatment, *Waste disposal, *Developing countries, *Urban areas, *Sanitation, *Djibouti, Sewers, Groundwater level, Public health, Water supply, Water quality control.

A two-person Water and Sanitation for Health (WASH) team visited Djibouti from 16 October through 5 November 1985 to identify training-related activities that could be support by USAID. The consultants also were asked to indicate the capabilities of the WASH project to supply the technical assistance necessary to carry out the proposed activities. The consultants' findings were: (1) Only a small part of the City of Djibouti has adequate sanitation services. A fragmented sanitary sewer system covers only a small proportion of the city and, as a result, sanitary wastes are illegally dumped into overloaded rainwater collection sewers. The Ministry of Public Works is unable to maintain the existing sewer systems properly; (2) High groundwater levels and high density settlement patterns cause septic tanks to overflow, especially in the low-income areas of the Old Wards and Balbala. No Government of the Republic of Djibouti (GROD) institution exists with either the responsibility or capability to assist in household sanitation improvements; (3) Several major projects currently are under way in Djibouti City that are rehabilitating or upgrading public water supply and sewerage services; and (4) No current GROD programs are directed toward individual household sanitation. A lack of knowledge exists concerning technically feasible and socially acceptable methods for disposal of household wastes, especially excreta and wastewater. (Lantz-PTT)
W89-05369

TRAINING OF TRAINERS WORKSHOP III AND TRAINING MATERIALS DEVELOPMENT FOR THE WATER AND SANITATION COMPONENT OF SANRU II,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
For primary bibliographic entry see Field 5F.
W89-05370

GUIDELINES FOR DESIGNING A HYGIENE EDUCATION PROGRAM IN WATER SUPPLY AND SANITATION FOR REGIONAL/DISTRICT LEVEL PERSONNEL,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
M. Simpson-Hebert, and M. Yacoob.
Water and Sanitation for Health Project Field Report No. 218, September 1987. 58p, 2 tab, 5 append. AID Contract 5942-C-00-4085-00, Project 936-5942.

Descriptors: *Developing countries, *Public health, *Education, *Sanitation, *Water supply development, *Management planning, Standards, Training, Public participation, Finances.

Hygiene education is now recognized as an important part of water supply and sanitation projects. However, a clean drinking water supply, increased amounts of domestic water, and better methods of human excreta disposal (latrines or sewerage) do not in themselves result in a more hygienic environment or reduction of disease. The consumers of these new facilities must use them, use them properly, and then often adopt new behaviors that will maximize the health benefits. The purpose of hygienic education is to bring about those complementary changes in behavior. This manual provides a guideline on how to develop a hygiene education program for a district or region of a country. The thirteen steps to designing a hygiene education program are: (1) Describe and evaluate the current program in water supply and sanitation hardware and software; (2) List all the group's concerns about the current program; (3) Identify community behaviors needing change; (4) Set general goals for the new hygiene education program; (5) Identify target groups for the new hygiene education program; (6) Identify hygiene education 'teachers' for each target group; (7) Set specific measurable goals for behavioral change that can be measured through a self-survey; (8) Develop a system for survey and reporting; (9) Develop a system for rewarding the communities for making changes; (10) Identify what assistance is needed by community groups, government agencies, and private voluntary organizations to carry out the program; (11) Budget for additional personnel and materials, if needed; (12) Plan for presentation of the program to communities; and (13) Review the new program for completeness and plan for its implementation. (Lantz-PTT)
W89-05372

COMMUNITY PARTICIPATION IN WATER SUPPLY PROJECTS AS A STIMULUS TO PRIMARY HEALTH CARE: LESSONS LEARNED FROM AID-SUPPORTED AND OTHER PROJECTS IN INDONESIA AND TOGO,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
For primary bibliographic entry see Field 5F.
W89-05374

BENIN RURAL WATER SUPPLY AND SANITATION PROJECT START-UP WORKSHOP, APRIL 7-10, 1987,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
For primary bibliographic entry see Field 5F.
W89-05375

MID-TERM EVALUATION OF THE CARE WATER SUPPLY AND SANITATION PROJECT IN BELIZE,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
For primary bibliographic entry see Field 5F.
W89-05376

REPORT ON TECHNICAL ASSISTANCE TO THE VILLAGE-LEVEL WATER AND SANITATION PROJECT, CARE/BELIZE,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
J. E. Turner.
Water and Sanitation for Health Project Field Report No. 193, July 1986. 29p, 2 append. AID Contract 5942-C-00-4085-00, Project 936-5942.

Descriptors: *Developing countries, *Education, *Water supply development, *Belize, *Sanitation, Rural areas, Evaluation, Construction, Wells, Pumps, Domestic wastes.

The CARE Village-Level Water and Sanitation (VLWS) Project, which is jointly funded by CARE and USAID, is a three-year effort focusing on approximately 1,600 households in the districts of Corozal and Orange Walk in northern Belize. The VLWS Project was initiated in July 1984 and will enter its third year in July 1986. The water supply component of the project will include the installation of up to 160 India Mark II handpumps (one per ten families by WHO/PAHO standards) on either new or rehabilitated wells. The project will also include the installation of supply sources and distribution systems (rudimentary water systems -- RWS) in two villages. The construction of rudimentary water systems was not included in the original project document but was added to the project in January 1986. The sanitation component of the project includes the construction and/or rehabilitation of up to 1,600 latrines (one per family). The overall project places a strong emphasis on health education for all age groups and includes both formal, school-based programs and nonformal, community-based education. The major conclusions and recommendations of the WASH consultant are summarized. In addition, the consultant reviewed CARE's water systems design procedures and discussed with CARE personnel a number of modifications to the procedures. Recommended standard procedures are given in an Appendix. (Lantz-PTT)
W89-05378

MALAWI SELF-HELP RURAL WATER SUPPLY PROGRAM: FINAL EVALUATION,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
For primary bibliographic entry see Field 5F.
W89-05379

MIDTERM EVALUATION OF THE USAID/CARE COMMUNITY WATER SYSTEMS DEVELOPMENT PROJECT IN THE REPUBLIC OF HAITI,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
P. Roark, and J. N. Smucker.
Water and Sanitation for Health Project Field Report No. 205, February 1987. 99p, 11 tab, 7 append. AID Contract 5942-C-00-4085-00, Project 936-5942.

Descriptors: *Haiti, *Developing countries, *Rural areas, *Water supply development, *Public participation, Potable water, Public health, Training, Water supply, Water resources development, Evaluation.

The Community Water Systems Development Project is a continuing rural water supply and sanitation project, commenced in July 1984 and implemented by CARE. The project plans to serve approximately 160,000 people in some 40 communities in the southern peninsula of Haiti by June 1988, using primarily capped springs and gravity-fed systems. The goals of the project are to improve the quality of life in the targeted communities and to strengthen community institutions to enable them to manage the water supply and sanitation systems constructed under the project. To accomplish these goals, the project designs and constructs potable water systems, promotes community participation and the strengthening of local institutions, and develops and implements user education and sanitation activities in all target communities. Training is provided for community leaders, community plumbers, and governmental counterparts. In April 1986, a three-person USAID team conducted a rapid assessment of the project, which has been the only formal evaluation to date. It was found that project administration and management are appropriate and proceeding well after a slow start. The likely number of sites to be completed is 29 rather than 40. Engineering design and logistics, and construction have been satisfactory. Operations and maintenance have not been sufficiently tested. Nineteen recommendations are made involving such methods to improve the rate of production, community participation, cost assessments, and assignment of financial responsibilities for the water systems. (Lantz-PTT)
W89-05381

FINAL EVALUATION OF USAID/CATHOLIC RELIEF SERVICES WATER AND SANITATION PROGRAM IN ECUADOR, PERU, GUATEMALA, HONDURAS AND THE DOMINICAN REPUBLIC,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
For primary bibliographic entry see Field 5F.
W89-05382

PRIVATIZATION STUDY OF THE VILLAGE WATER SUPPLY AND SANITATION (VWSS) PROJECT LESOTHO,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
For primary bibliographic entry see Field 5F.
W89-05383

PREPARATION OF A PLAN OF ACTION FOR THE WATER SUPPLY AND SANITATION COMPONENT OF THE ADB-SPONSORED RURAL HEALTH SERVICES PROJECT IN PAPUA, NEW GUINEA,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
J. Haratani, and J. K. Jordan.
Water and Sanitation for Health Project Field Report No. 208, April 1987. 108p, 10 ref, 12 append. AID Contract 5942-C-00-4085-00, Project 936-5942.

Descriptors: *Management planning, *Water supply development, *Sanitation, *Papua, *Developing countries, New Guinea, Rural areas, Water management, Public health.

ADB-1, the first Rural Health Services Project supported by the Asian Development Bank and being implemented in six provinces of Papua, New Guinea, is entering its fifth, and possibly its final, year. ADB-2, the second project covering the balance of the nation's 19 provinces, is entering its second year of implementation. In early 1986, a WASH consultant team conducted an evaluation of the rural water supply and sanitation component of ADB-1. The present WASH team has been asked to assist the Department of Health in placing the recommendations made in the evaluation into effect. The purpose of this workshop was to present the WASH team's findings and conclusions and to have the participants challenge, modify, and confirm them. In addition to describing national- and provincial-level tasks, the WASH team identified and described specific subject areas where external technical assistance is needed. The team also drafted preliminary terms of reference to be used to initiate the process of obtaining the necessary technical assistance services. Finally, this report presents some final observations and conclusions, covering the management and operations of the rural water supply and sanitation program as well as pointing out issues which affect the health establishment as a whole. (Lantz-PTT)
W89-05385

FINAL EVALUATION: USAID/BURKINA FASO RURAL WATER SUPPLY PROJECT,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
For primary bibliographic entry see Field 5F.
W89-05387

TRAINING PROGRAM IN VILLAGE WATER SUPPLY PLANNING, MANAGEMENT, DESIGN, CONSTRUCTION, AND MAINTENANCE IN NEPAL: MAY 25 TO JUNE 13, 1986,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
For primary bibliographic entry see Field 5F.
W89-05388

ENGINEERING/COST EVALUATION OF OPTIONS FOR REMOVAL/DISPOSAL OF NC FINES,
Little (Arthur D.), Inc., Cambridge, MA.
A. A. Balasco, J. M. Nystrom, J. J. Stahr, and L. L. Smith.
Available from the National Technical Information Service, Springfield, VA 22161, as AD-A192 028. Price codes: A04 in paper copy, A01 in microfiche. Task order no. 3/Subtask 3.5. Final Report, September, 1987. 71p, 10 fig, 19 tab, 9 ref, 3 append. Army Contract DAAK11-85-D-0008.

Descriptors: *Wastewater treatment, *Waste disposal, *Nitrocellulose, *Industrial wastewater, Economic aspects, Centrifugation, Filtration, Incineration, Sludge digestion, Chemical treatment, Alkalinity, Biological wastewater treatment.

The various options for recovering and treating/disposing of the nitrocellulose (NC) present in the manufacturing wash streams at the Radford Army Ammunition Plant (RAAP) were evaluated. These include: sliding bowl centrifugation for preconcentrations, cross-flow microfiltration for final concentration, solid bowl centrifugation for final concentration, incineration for disposal of NC sludge, and alkaline digestion for pretreatment prior to biological treatment for disposal. The evaluation focussed on the economics of the various technologies, but also addressed the performance characteristics and technical risk associated with implementation of the various process options which could be configured from the evaluated technologies. The most desirable options, all involved the use of cross-flow microfiltration as a concentrating/recovery step. Likewise, alkaline digestion as a pretreatment method prior to biological treatment/disposal was involved with the majority of the most promising options. Two of the three options with the lowest capital and operating costs also involved both cross-flow microfiltration and alkaline digestion. It was recommended that a pilot test program be conducted to further investigate cross-flow filtration and alkaline digestion as the preferred methods for concentration/recovery and disposal of NC fines. (Lantz-PTT)
W89-05395

PRELIMINARY TREATMENT FACILITIES: DESIGN AND OPERATIONAL CONSIDERATIONS.
Environmental Protection Agency, Washington, DC. Office of Municipal Pollution Control.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-124078. Price codes: A04 in paper copy, A01 in microfiche. EPA Report 430/09-87-007, September 1987. 63p, 10 tab, 56 ref.

Descriptors: *Wastewater treatment, facilities, *Design standards, *Municipal wastewater Operating policies, Wastewater treatment, Anaerobic digestion, Aerobic treatment, Sedimentation, Filtration, Separation, Incineration, Grit removal.

This report provides a basic understanding of preliminary wastewater treatment systems and presents concise information on design considerations, operational characteristics, and process and equipment problems and possible solutions. Treatment components include: primary sedimentation, activated sludge-aeration, trickling filters, rotating biological contactors, oxidation ditches, secondary sedimentation, heat treatment, anaerobic digestion, aerobic digestion, vacuum filters, centrifugation, belt filter presses, recessed plate filter presses, and incineration systems. Recommended design practices are outlined for grit and screenings removal systems for both large and small (< 1 million gal/day) municipal wastewater plants. (Lantz-PTT)
W89-05400

ENVIRONMENTALLY RELEVANT CHARACTERISTICS OF OIL-IN-WATER EMULSIONS,
Alberta Univ., Edmonton. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W89-05436

CHRONIC HYDROCARBON DISCHARGES INTO AQUATIC ENVIRONMENTS: I. MUNICIPAL TREATMENT FACILITIES,
Rhode Island Univ., Narragansett. Graduate School of Oceanography.
E. J. Hoffman, and J. G. Quinn.
IN: Oil in Freshwater: Chemistry, Biology, Countermeasure Technology. Pergamon Press, New York, NY, 1987. Edited by John H. Vandermeulen and Steve E. Hrudey. p 97-113, 2 fig, 11 tab, 43 ref.

Descriptors: *Hydrocarbons, *Oil, *Wastewater treatment, *Water pollution sources, *Oil pollution, Municipal wastes, Particulate matter, Biodegradation, Rhode Island, Recycling, Oil recovery, Industrial wastes.

The literature on petroleum hydrocarbon discharges from municipal wastewater treatment facilities was reviewed with emphasis on comparisons of concentrations and discharge rates, chemical nature of the hydrocarbons, sources of hydrocarbons to the plants and treatment mechanisms and rates. Although the concentrations and mass per capita discharge rates of petroleum hydrocarbons varied greatly among the various facilities, the hydrocarbon/solids ratio was similar among plant effluents. All of the studies reported that the hydrocarbons in the plant effluents were largely associated with particulate matter although the chemical nature of the hydrocarbons were variable with location. A wide variety of petroleum products have been reported in the domestic and industrial wastewater entering sewage treatment plants. Industrial sources contribute the majority of the hydrocarbons to the Providence, Rhode Island wastewater facility. Biodegradation and volatilization are minor processes in removal of hydrocarbons from the wastewater. Abatement of hydrocarbons from municipal wastewater effluents can be achieved through improved treatment efficiencies for solids and through source control techniques (e.g. industrial pretreatment, waste oil recycling). (See also W89-04530) (Author's abstract)
W89-05439

TECHNOLOGY FOR REMOVAL OF HYDROCARBONS FROM SURFACE AND GROUNDWATER SOURCES,
Engineering-Science, Inc., Austin, TX.
D. L. Ford.
IN: Oil in Freshwater: Chemistry, Biology, Countermeasure Technology. Pergamon Press, New York, NY, 1987. Edited by John H. Vandermeulen and Steve E. Hrudey. p 413-430, 11 fig, 28 ref.

Descriptors: *Water pollution treatment, *Oil spills, *Hydrocarbons, *Cleanup operations, *Wastewater treatment, *Oil pollution, *Groundwater pollution, Oil recovery, Biological wastewater treatment, Separation techniques, Aeration, Membrane processes, Adsorption, Activated carbon, Case histories, Sedimentation, Flocculation, Coagulation.

State-of-the-art treatment technology relative to the removal of oil and grease and soluble hydrocarbons from surface and groundwaters is discussed. Biological treatment represents the best technology for removing organic constituents from most municipal and industrial. wastewaters. One of the most critical unit processes in the successful biological treatment of industrial wastes is equalization. Mixing systems should be added to treatment systems which have been previously unmixed. The liquid temperature effects on biochemical oxidation rates are an important consideration in upgading or enhancing effluent quality for many wastewaters. Upgrading treatment facilities based on temperature-related problems can be based on increasing sludge age by building up the mixed liquor inventory of biomass, or increasing the mixed liquor temperature by adding an external source of heat. The aeration system can be physically modified to enhance the oxygenation capacity; the influent to the aeration basin can be oxygenated to saturation or near saturation, and the biomass inventory in the aeration basin can be reduced. The ability of activated carbon to upgrade a treatment system by removing organic and selected inorganic constituents should first be tested using batch reactors in an isotherm approach. Several municipal and industrial experiences that used powdered activated carbon-activated sludge processes are reviewed. Oil removal from surface and groundwaters can be accomplished by gravity separation, dissolved air flotation, chemical coagulation-flocculation and sedimentation, membrane processes, biological processes, and carbon adsorption. Some case histories and effluent quality data from selected full-scale treatment plants for petroleum refinery wastewaters are analyzed. Methods for reducing aquifer contamination from hydrocarbons include the installation of development wells at predetermined locations, and injection of the treatment medium (i.e. nutrients to support microbial growth) directly into the aquifer. (See also W89-04530) (Geiger-PTT)
W89-05458

PRINCIPLES FOR THE SEPARATION OF OIL DROPS FROM WATER IN GRAVITY TYPE SEPARATORS,
British Columbia Univ., Vancouver. Dept. of Civil Engineering.
R. Branion.
IN: Oil in Freshwater: Chemistry, Biology, Countermeasure Technology. Pergamon Press, New York, NY, 1987. Edited by John H. Vandermeulen and Steve E. Hrudey. p 431-442, 10 fig, 4 tab, 13 ref.

Descriptors: *Oil pollution, *Separation techniques, *Wastewater treatment, *Oil recovery, Gravity filters, Performance evaluation, Flotation, Cost analysis, Oily water, Mathematical analysis, Design criteria.

Some principles and applications of oil drop separation are reviewed. The mathematical principles of drop separation and drop size distribution are discussed. A method for determining the effectiveness, in terms of fractional oil removal, of gravity type oil-water separators is described. The method requires a knowledge of the distribution of oil drop sizes in the influent wastewater. Its application to the design of batch separation tanks, pools (pit ponds and lagoons), API separators and parallel plate separators is described. The design principles for sizing the equipment, and/or determining the oil removal effectiveness for a system of separator units are similar to those discussed for single separators. Comparison of calculated effectiveness and measured effectiveness shows reasonable agreement. (See also W89-04530) (Author's abstract)
W89-05459

NOTE ON PETROLEUM REFINERY WASTEWATER TRACE CONTAMINANTS BEFORE AND AFTER BIOLOGICAL TREATMENT,
Bayerische Landesanstalt fuer Wasserforschung, Munich (Germany, F.R.).
L. Huber, W. Kalbfus, and H. Baumung.
IN: Oil in Freshwater: Chemistry, Biology, Countermeasure Technology. Pergamon Press, New York, NY, 1987. Edited by John H. Vandermeulen and Steve E. Hrudey. p 443-445, 3 tab.

Descriptors: *Oxidation ponds, *Wastewater treatment, *Biological wastewater treatment, *Oil pollution, *Trace metals, *Wastewater characteristics, Oil refineries, Germany, Hydrocarbons, Aromatic compounds, Cadmium, Copper, Vanadium, Chromium, Nickel, Lead, Phenols.

Influent and effluent samples of the wastewater treatment units of six oil refinery plants in the Federal Republic of Germany were analyzed to assess the effects of biological wastewater treatment operations on wastewater characteristics. Three of the refineries used aerated oxidation ponds as a final biological treatment stage. Results showed that benzene, toluene, xylene (BTX) aromatics are the dominant compounds in the influents to the biological treatment plants. Concentrations for the aliphatic hydrocarbons decreased with increasing chain length starting from n-decane. Biodegradation or elimination in the biological stage was 99-99.5% for the BTX aromatics while the removal rate for the aliphatic hydrocarbons decreased with increasing chain length from 99% to 90%. For polycyclic aromatics the concentration of the higher molecular weight compounds in the influent to the activated sludge plants was lower than 50 ng/L. The efficiency of the aerated ponds on the removal of organics is clearly discernible in the case of the BTX aromatics. Volatile phenols are also degraded or eliminated to a very high degree. With special reference to the hydrocarbons, refinery wastewaters after extensive biological treatment should generally pose no environmental hazard for discharge into surface waters. Monitoring of heavy metals and other major elements including metalloids was particularly directed at toxic and bioaccumulating heavy metals such as cadmium, chromium, copper, nickel, lead and vanadium. Results were found in the 5 to 50 microgram/L range. For many of the elements, drinking water standards were regularly attained in the effluents. (See also W89-04530) (Geiger-PTT)
W89-05460

NEW PARTICIPATORY FRAMEWORKS FOR THE DESIGN AND MANAGEMENT OF SUSTAINABLE WATER SUPPLY AND SANITATION PROJECTS,
United Nations Development Programme, Washington, DC.
For primary bibliographic entry see Field 5F.
W89-05514

FRAMEWORK AND GUIDELINES FOR CARE WATER SUPPLY AND SANITATION PROJECTS,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
For primary bibliographic entry see Field 5F.
W89-05515

VALUE OF WATER SUPPLY AND SANITATION IN DEVELOPMENT: AN ASSESSMENT OF HEALTH-RELATED INTERVENTIONS,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
For primary bibliographic entry see Field 5F.
W89-05518

RURAL WATER SUPPLY AND SANITATION PROGRAM IN THE SOLOMON ISLANDS,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
For primary bibliographic entry see Field 5F.
W89-05523

PREPARATION OF A NATIONAL RURAL WATER SUPPLY AND SANITATION PLAN IN ZAIRE,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
For primary bibliographic entry see Field 5F.
W89-05524

PVO EFFECTIVENESS IN THE WATER SUPPLY AND SANITATION SECTOR,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
For primary bibliographic entry see Field 5F.
W89-05525

EVALUATION OF THE WATER SUPPLY AND SANITATION COMPONENT OF THE ADB-SPONSORED RURAL HEALTH SERVICES PROJECT IN PAPUA NEW GUINEA,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
For primary bibliographic entry see Field 5F.
W89-05526

METHODS FOR THE TREATMENT OF CONTAMINATED DREDGED SEDIMENTS,
Hoofdgroep Maatschappelijke Technologie TNO, Apeldoorn (Netherlands).
W. J. Van Gemert, J. Quakernaat, and H. J. Van Veen.
IN: Environmental Management of Solid Waste: Dredged Material and Mine Tailings. Springer-Verlag, New York, NY. 1988. p 44-64, 3 tab, 6 fig, 16 ref.

Descriptors: *Hydrocyclones, *Solid waste disposal, *Dredging, *Spoil banks, *Waste disposal, *Spoil disposal, The Netherlands, Decontamination, Biological treatment, Flotation, Centrifugation.

In the Netherlands dumping of residues including sediments must not exceed contamination levels higher than specified in the Chemical Waste Act. These types of residue have to be decontaminated or must be transported out of the country for ultimate controlled storage at a suitable location. There are two categories of treatment techniques: (1) Large-scale concentration characterized by low costs per unit of residue to be treated, and a low sensitivity to variations in circumstances; (2) Decontamination or concentration especially suited for the treatment of residues which contain higher concentrations of contaminants which involves higher operating costs and more complicated techniques. Large-scale concentration techniques include: hydrocyclonage, flotation, and high gradient magnetic separation. Decontamination or concentration techniques include: biological treatment, NaOCl leaching, acid leaching, ion exchange, solvent extraction, thermal treatment, wet air oxidation, dewatering, and electro-osmotic dewatering. Results showed hydrocyclonage a suitable large-scale technique. In sediments, the fine fraction has higher contamination levels than the coarse fraction. Using hydrocyclones for this purpose is logical because they classify particles in a slurry at cut sizes up to 10 microns. There are two options for treatment of the fine fraction: dewatering and/or decontamination. Dewatering as a technique can be used when decontamination is not feasible or unavailable on a practical scale. It is also possible that dewatering will be required after decontamination. In some cases it is necessary to treat the water separated in the dewatering process. This depends, among other things, on the type of dewatering technique. For instance, the filtration generally produces a better water quality than centrifugation. The feasibility of decontamination of the contaminated sediment is dependent on factors such as: (1) the type of contaminant; (2) the complexity of the contaminants (cocktails); (3) the environmental merit. Investigations show not all decontamination techniques are universally suitable. Thus, in each case some preliminary experiments are required in order to choose a suitable decontamination technique. (See also W89-05568) (White-Reimer-PTT)
W89-05571

CLASSIFICATION AND DEWATERING OF SLUDGES,
Technische Univ. Hamburg-Harburg (Germany, F.R.).
J. Werther.
IN: Environmental Management of Solid Waste: Dredged Material and Mine Tailings. Springer-Verlag, New York, NY. 1988. p 65-79, 3 tab, 17 fig, 15 ref.

Descriptors: *Sludge drying, *Dredging, *Solid waste disposal, *Dewatering, Separation techniques, Hydrocyclones, Elutriator, Centrifugation, Harbors, Heavy metals.

A classification of the dredged river sediments leads to a separation of an uncontaminated sand fraction from the contaminated harbor sludge. The separation process reduces the amount of contaminated material and thus reduces the costs of further treatment or disposal. The classification is most effectively carried out by a hydrocyclone with subsequent washing of the underflow in an elutriator. The sludge suspension is tangentially introduced into the cyclone chamber where the separation of the coarse fraction from the fines is effected by the action of centrifugal forces. The coarse fraction leaves the cyclone in the underflow, while the fines are contained in the overflow. The underflow of the hydrocyclone still contains a considerable mass fraction in the size range below 60 microns, i.e. this underflow material will still be contaminated with heavy metals. The classification may either be improved by suitable combination of two or more stages of hydrocyclones or by washing the underflow of the hydrocyclone in an elutriator where the liquid-fluidized bed forming at the bottom section of the apparatus provides a very effective means to clean the coarse fraction from adhering fines. The elutiator effects a much better sharpness of separation. The basic principle of separation is here separation according to the settling velocity of the particles in an upflowing water stream. The fluidized bed of coarse particles forming at the bottom part of the apparatus aids in washing the underflow by particle-to-particle interaction in the bed. Virtually no fines are found in the underflow of the elutriator. The sand thus separated from the sludge has a heavy metal content which is of the same order of magnitude found in naturally occurring sandstones. The basic principle of separation For the dewatering of the remain-

ing fine sludge suspension, a two-stage centrifugation in decanting centrifuges has turned out to be most advantageous. The flow scheme of a technical sludge processing plant has been developed based on the process steps testing in a pilot plant. (See also W89-05568) (White-Reimer-PTT)
W89-05572

INTEGRATED BIOLOGICAL SYSTEMS FOR EFFLUENT TREATMENT FROM MINE AND MILL TAILINGS,
Randol International Ltd., Golden, CO.
H. Von Michaelis.
IN: Environmental Management of Solid Waste: Dredged Material and Mine Tailings. Springer-Verlag, New York, NY. 1988. p 99-113, 2 tab, 24 ref.

Descriptors: *Wastewater treatment, *Mine wastes, *Mills, *Mine drainage, *Acid mine drainage, *Biological wastewater treatment, *Biological treatment, Lagoons, Wastewater lagoons, Metals, Heavy metals, Trace metals, Organics, Cyanide.

There are numerous cases where biological systems (plants, algae, fungi, bacteria, biomass, and enzymes, etc.) have been shown to remove metals and other contaminants, such as sulfate and cyanide. from effluent solutions. The application of integrated biological processes simultaneously under both aerobic and anaerobic conditions in artificial marshes may be one way to enhance the scope of biological effluent treatment. Biological systems must be site-specific, and initially such systems may be best applied to polish effluents rather than for primary treatment. Climatic constraints present a limiting factor in applying passive biological systems. Examples of passive and experimental systems are reviewed; metals polishing by natural marshes, artificial meandering lagoons, artificial and natural bog/pond treatment; ability of sphagum moss to convert ferrous iron to ferris hydroxide which is then coagulated and flocculated by plants at plt 2.5 and subsequently converted to sulfide; removal of particulate selenium and uranium by algae; use of wood chips and other agricultural waste as a carbon source and substrate for a bacterial culture capable of removing sulfate from water; and removal of cyanide by either volatilization or by mixing a cyanide effluent with sewage providing a substrate for cyanide-oxidizing bacteria. If water is recycled to the metallurgical operation, then the effect of the biological treatment system on water quality must be taken into account. (See also W89-05568) (White-Reimer-PTT)
W89-05574

STUDY ON TITANIUM CHLORINATION SOLID WASTES,
Krispar Technologies, Inc., Glendale, CA.
R. Krishnaswamy, and N. H. Parker.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-159801. Price codes: A06 in paper copy, A01 in microfiche. 184p, 16 fig, 29 tab 84 ref, 6 append. Bureau of Mines Contract J0145946.

Descriptors: *Waste recovery, *Titanium, *Chlorination, *Wastewater treatment, Solid wastes, Costs, Pyrohydrolysis, Recycling, Pelletization, *Fate of pollutants.

The conceptual designs and the results of tests on processes used to recover titanium from solid waste, are presented. Recoveries of 80% to 88% of the titanium in the waste as a concentrate of 90% to 99% titanium dioxide were achieved, thus reducing the amount of final waste effluent to < 40% of current quantities. It was estimated that a 1,000 lb/h plant, with an installed cost of $888,000, would recover about 1,320 tons of titanium minerals a year, representing a revenue of $607,200. Allowing for operating expenses, return on investment would be 28%. The technical feasibility of pyrohydrolysis as an alternative final effluent treatment was established. Conceptual designs of pyrohydrolysis pelletization of concentrates, secondary chlorinator, and treatment of currently ponded tailings are presented. Overall treatment resulting in low quantities of inert, nontoxic, and nonindustry final solid waste, reuseable titanium mineral concentrates, and maximum recycle of process water is also discussed. (Author's abstract)
W89-05760

WATER AND WASTEWATER TREATMENT INVENTORY AND THE PERCEPTION OF WASTEWATER ENGINEERS ON CONSIDERATIONS AFFECTING TREATMENT ALTERNATIVES,
Air Force Inst. of Tech., Wright-Patterson AFB, OH.
V. E. Renaud.
Available from the National Technical Information Service, Springfield, VA 22161, as AD-A188-105. Price codes: A04 in paper copy, A01 in microfiche. Master's Thesis. Report No. AFIT/GEM/DEM/87S-20, September 1987. 75p, 4 fig, 5 tab, 11 ref, 3 append.

Descriptors: *Water treatment, *Wastewater treatment, *Drinking water, Wastewater treatment facilities, Filtration, Wells, Industrial wastewater, Military bases.

The purpose of this study was to compile an inventory of water and wastewater treatment methods for all CONUS Air Force installations and to determine the importance of the considerations affecting domestic wastewater treatment alternatives. The inventory provides the baseline data for managers to use in making future policy. The inventory revealed that the majority of CONUS Air Force installations have regional connections. The most common type of treatment for bases with on base treatment plants is trickling filters. Industrial wastewater treatment is found at only 22 bases-most of these are only pretreatment facilities. The most common drinking water source is wells and, accordingly, the majority of bases treat their drinking water themselves. Cost and pollution abatement tied for the most important factors to consider when making an analysis of treatment alternatives. Location of the regional system ranked next in importance followed by a tie between the quantity of wastewater to be treated and the importance of the wastewater operator as a critical military skill. The findings of this research reemphasize the need for reciprocity between the states for certification of wastewater operators. Additionally, since many on-base plants were constructed prior to the mid 1950s, it is recommended that major upgrades to these plants be considered so that compliance with the increasingly stringent standards is maintained. Additional research is recommended in this field. Specifically, a complete inventory should be compiled and maintained to keep track of problems or trends in treatment methods. (Author's abstract)
W89-05764

SENSITIVITY CONSTRAINED NONLINEAR PROGRAMMING: A GENERAL APPROACH FOR PLANNING AND DESIGN UNDER PARAMETER UNCERTAINTY AND AN APPLICATION TO TREATMENT PLANT DESIGN,
Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.
For primary bibliographic entry see Field 6A.
W89-05789

5E. Ultimate Disposal Of Wastes

HYDROGEOLOGY OF SEDIMENTARY BASINS: APPLICATION TO EXPLORATION AND EXPLOITATION.
For primary bibliographic entry see Field 2F.
W89-04565

COMPOSITION OF WATER IN WASTE WELL DISPOSAL FROM OIL SANDS AND HEAVY OIL FIELD PILOTS OF ALBERTA,
Alberta Research Council, Edmonton.
W. D. Gunter, B. J. Fuhr, and B. Young.
IN: Hydrogeology of Sedimentary Basins: Application to Exploration and Exploitation. National Water Well Association, Dublin, OH. 1986. p 233-249, 11 fig, 3 tab, 9 ref.

Descriptors: *Underground Waste disposal, *Disposal wells, *Oil wastes, *Alberta, *Wastewater analysis, *Oil fields, *Chemical properties, Model studies, Computer models, Minerals, Ions, Steam, Combustion, Recharge, Injection wells, Geologic formations, Wastewater disposal, Sodium chloride, Hydrogen ion concentration.

Waste waters from 12 different oil sand and heavy oil field pilots in Alberta employing in situ steam or in situ combustion recovery techniques have been analyzed to define the chemistry of the disposal water in subsurface waste disposal. Waste water samples from the five main oil sand deposits (Athabasca, Cold Lake, Grosmont, Peace River and Wabasca) as well as from the heavy oil area around Lloydminster, were included. All similar groups of ions (e.g., alkali metals, alkaline earth metals, halides) contained in the waste waters exhibited similar trends across the pilots. The waters were predominantly of the NaCl type. Calcium, magnesium and bicarbonate were relatively high. The pH ranged from 5 to 9. H2S was prominent at several sites. In those pilots in which a combustion process was employed, the highest concentration of low molecular weight (1 to 4 carbon) carboxylic acids and sulfate were observed. Compatibility between these waste waters and the formation waters from two potential disposal formations (one a sandstone, the basal Lower Cretaceous McMurray Formation and the other a limestone of Devonian age, the Beaverhill Lake Formation) was tested using the computer model SOLMNEQF. Each waste water was mixed with the formation waters, and the saturation indices of a number of minerals in both the mixed and unmixed waters were calculated. Amorphous silica and calcite were predicted to precipitate from the waste waters and could create a problem by reducing the injectivity to the disposal formation over a period of time. (See also W89-04583) (Author's abstract)
W89-04583

CASE STUDIES OF DEEP WELL HAZARDOUS WASTE DISPOSAL - GULF COAST, GREAT LAKES AND CALIFORNIA,
Engineering Enterprises, Inc., Norman, OK.
T. Syed, J. S. Fryberger, R. M. Tinlin, and A. R. Anzzolin.
IN: Hydrogeology of Sedimentary Basins: Application to Exploration and Exploitation. National Water Well Association, Dublin, OH. 1986. p 250-257, 11 fig, 4 ref.

Descriptors: *Underground waste disposal, *Disposal wells, *Deep wells, *Injection wells, *Hazardous materials, Geohydrology, Hydraulics, Case studies, Planning, Hydraulic engineering, Groundwater pollution, Waste disposal.

Deep well injection is the predominant method of disposing hazardous wastes in the United States, injecting approximately 11.5 billion gallons (two-thirds of all hazardous waste disposed), through 195 wells in 1983. The vast majority of the wells are located in the Gulf Coast (68 percent) and Great Lakes (20 percent) states, with the chemical industry being the biggest user (88 percent). The safe disposal of toxic, hazardous wastes is undoubtedly the principal environmental issue of the 1980s. The Hazardous and Solid Waste Amendments of 1984 include a 'hammer' provision that will ban deep well disposal of certain hazardous wastes if the United States Environmental Protection Agency does not determine its safety by August 1988. Given this scenario and the large volumes and low cost associated with deep waste disposal, safe waste disposal in deep wells has assumed an important and urgent dimension. Injection wells when sited properly and when designed, constructed and operated properly can safely store waste fluids in an injection zone. Three case histories of Class I (HW) disposal wells located in the Gulf Coast, the Great Lakes and in California respectively show that if rigorous hydrogeologic, engineering and other technical criteria are not met, the potential for well failures and/or contamination of underground sources of drinking water can be high. Conversely, with the application of strict technical criteria and prudent operating practices, toxic, hazardous wastes in commercial quantities

can be stored safely in deep injection horizons. (See also W89-04565) (Author's abstract)
W89-04584

CONSIDERATIONS IN THE DEVELOPMENT OF A PROPOSED MONITORING AND TESTING PROGRAM TO ASSESS THE IMPACT OF SUBSURFACE WASTE INJECTION,
INTERA Technologies Ltd., Ottawa (Ontario). Hydrogeology Group.
For primary bibliographic entry see Field 7A.
W89-04585

DYE TRACING STUDIES OF THE FOUNTAIN, MINNESOTA SEWAGE SYSTEM,
Minnesota Univ., Minneapolis. Dept. of Geology and Geophysics.
E. C. Alexander, and J. A. Milske.
IN: Proceedings of the Environmental Problems in Karst Terranes and Their Solutions Conference. National Water Well Association, Dublin, OH. 1986. p 249-262, 5 fig, 1 tab, 7 ref.

Descriptors: *Karst, *Wastewater Disposal, *Tracers, *Septic tanks, *Soil disposal fields, Dye releases, Effluents, Aquifers, Groundwater pollution, Groundwater movement.

The community of Fountain MN is considering the construction of a community drainfield to alleviate the sewage disposal problem. The effluent from individual septic tanks would be collected and piped to a drainfield about two miles south of town. The proposed drainfield site is stratigraphically below the Decorah Shale in a valley underlain by limestones and dolomites of the Prairie du Chien Group. Watson Creek, which flows through the valley, is a karst stream which loses water into the ground in the vicinity of the proposed site. The quantitative dye trace from the proposed site indicates that the water beneath it is moving southeast at a velocity of about 1.3 miles/yr. Water in the lower karst aquifer (in the Prairie du Chien) is moving two to three orders of magnitude more slowly than in the upper karst aquifer (in the Galena). C-14 analyses of the water in the Prairie du Chien aquifer are consistent with the dye trace results and indicate residence times of < 25 yr. The results indicated that the proposed project will adversely affect a heavily used aquifer. (See also W89-04598) (Hammond-PTT)
W89-04598

CASE STUDY: REMEDIATION OF KARST COLLAPSES IN WATER/WASTEWATER IMPOUNDMENTS,
Syntex Agribusiness, Inc., Springfield, MO.
For primary bibliographic entry see Field 5G.
W89-04605

USE OF GROUND PENETRATING RADAR TECHNIQUES TO AID IN THE DESIGN OF ON-SITE DISPOSAL SYSTEMS,
University of Central Florida, Orlando.
For primary bibliographic entry see Field 7B.
W89-04613

GEOLOGY FOR PLANNING IN BOONE AND WINNEBAGO COUNTIES,
Illinois State Geological Survey Div., Champaign.
For primary bibliographic entry see Field 2F.
W89-04626

GEOLOGY FOR PLANNING IN BOONE AND WINNEBAGO COUNTIES.
Illinois State Geological Survey Div., Champaign.
For primary bibliographic entry see Field 8E.
W89-04641

SLUDGE TREATMENT AND DISPOSAL IN A TROPICAL ENVIRONMENT,
RCP and Associates, Rio Piedras, PR.
R. Cruz Perez.
IN: Third Caribbean Islands Water Resources Congress. Proceedings of a Symposium held in St. Thomas, U.S. Virgin Islands, July 22-25, 1986. p 69-72.

Descriptors: *Biological wastewater treatment, *Sludge drying, *Sludge disposal, *Puerto Rico, *Tropical regions, Precipitation, Evaporation, Evapotranspiration, Humidity, Wastewater facilities, Dikes, Economic aspects.

The drying of sludges by solar evaporation in open drying beds has been the principal system utilized by public utilities and industry. At both wastewater-treatment facilities in Cidra, Puerto Rico, open drying beds had been used for years with varying degrees of success. It was decided to utilize a covered drying bed as an option to maintain the full advantages of the evapotranspiration effects; it was also decided to utilize a translucent material for the drying-beds cover. In one of the facilities it was decided to upgrade the existing drying beds; at the other, new beds were constructed, utilizing some of the diking and structural members of the existing one. At the facility where existing drying beds were utilized, a simple cover manufactured of redwood as supporting elements, and translucent green fiberglass as cover material was used. In the new facility special plexiglass material was used, the frame structural members are steel and aluminum, and a humidity-removal system is installed. A substantial improvement over existing drying beds was obtained by the placement of simple and inexpensive covers, eliminating the effect of precipitation on a solar-evaporation drying bed. Until recently, this system had been limited to use in higher latitudes; its use in the tropics is a feasible, economical, and practical alternative. (See also W89-04665) (Shidler-PTT)
W89-04677

PROCESS DYNAMICS OF COMPOSTING: A PROPOSED STUDY,
Puerto Rico Univ., Mayaguez. Dept. of Chemical Engineering.
L. Morell de Ramirez.
IN: 3rd Caribbean Islands Water Resources Congress. Proceedings of a Symposium held in St. Thomas, U.S. Virgin Islands, July 22-25, 1986. p 91-94, 2 fig, 7 ref.

Descriptors: *Biological wastewater treatment, *Sludge disposal, *Composting, Dynamics, Regulations, Capital costs, Research priorities, Experimental design, Statistical methods, Simulation analysis, Puerto Rico.

In complying with the requirements for wastewater treatment stated in the Clean Water Act, municipalities face a major problem--sludge management. Composting sewage sludge offers several advantages over other sludge-management alternatives, among them: lower energy requirements and capital investment than incineration; a more-manageable product than land application; and a more productive, beneficial use of sludge than landfilling or ocean disposal. Since the composition of sludges varies according to their stage and type of treatment, each composting process has to be uniquely studied, based on the various physical, chemical and biological parameters involved. In order to study the operational parameters of the composting process and to evaluate the performance of various potential locally-available bulking materials, a research proposal was submitted to the Water Resources Institute. A small bench-scale composting system will be used. The trials set up will be done according to a statistically-designed experiment. A simulation model of the aerated static-pile composting method will be developed using data from experimental studies. The proposed research would provide an essential base for the development of sludge-composting operations in Puerto Rico as well as in other regions having similar process characteristics. (See also W89-04665) (Shidler-PTT)
W89-04682

MODIFICATION OF WATER QUALITY IN IVUJIVIK (NORTHERN QUEBEC, CANADA),
Quebec Univ., Montreal.
For primary bibliographic entry see Field 5D.
W89-04720

EFFECTS OF HARVESTING ON REGENERATION AND BIOLOGICAL PRODUCTION OF PHRAGMITES AUSTRALIS IN WETLANDS,
Tohoku Univ., Sendai (Japan). Biological Inst.
For primary bibliographic entry see Field 4C.
W89-04722

EPA'S WASTE MINIMIZATION RESEARCH PROGRAM,
Environmental Protection Agency, Cincinnati, OH. Hazardous Waste Engineering Research Lab.
C. J. Dial.
Availalble from the National Technical Information Service, Springfield, VA 22161, as PB88-148085. Price codes: A02 in paper copy, A01 in microfiche. Report No. EPA/600/D-87/365, December 1987. 5p, 1 tab.

Descriptors: *Waste disposal, *Waste management, *Environmental policy, *Public policy, Legal aspects, Political aspects, EPA policy, Hazardous materials.

The Hazardous Waste Engineering Reseach Laboratory, in conjunction with the Office of Solid Waste, is developing a Waste Minimization Program for implementation in Fiscal Year 88. The EPA has adopted the following hierarchy as a guide for hazardous waste management options: (1) waste reduction, (2) waste separation and concentration, (3) waste exchange, (4) energy/material recovery, (5) incineration/treatment, and (6) secure land disposal. Barriers that inhibit the implementation of waste management action include; lack of awareness, fear of upsetting a product's quality, organizational inertia, internal politics of the organization, and rejection of innovative approaches. The EPA has developed several programs to reduce technical barriers and to provide support and guidance for individual programs. (White-Reimer-PTT)
W89-04749

ANALYTICAL TECHNIQUES AND RESIDUALS MANAGEMENT IN WATER POLLUTION CONTROL SPECIALTY CONFERENCE APRIL 19-20, 1988.
For primary bibliographic entry see Field 5G.
W89-04782

AUTOMATED DIRECT MEASUREMENTS OF TOTAL CYANIDE SPECIES AND THIOCYANATE IN PRESENCE OF EACH OTHER,
Metropolitan Sanitary District of Greater Chicago, IL.
For primary bibliographic entry see Field 5A.
W89-04784

AQUATIC TOXICITY TESTING FOR HAZARDOUS MATERIALS,
Patapsco Wastewater Treatment Plant, Baltimore, MD.
For primary bibliographic entry see Field 5A.
W89-04793

CITY OF NASHVILLE COMPOSTING OPERATIONS,
E and A Environmental Consultants, Inc., Stoughton, MA.
For primary bibliographic entry see Field 5D.
W89-04795

CITY OF AUSTIN SLUDGE REUSE PROGRAM,
Camp, Dresser and McKee, Inc., Austin, TX.
J. Doersam, and G. A. Edwards.
IN: Analytical Techniques and Residuals Management in Water Pollution Control Specialty Conference April 19-20, 1988. Water Pollution Control Federation, Alexandria, VA 22314-1994. p 7-13, 2 fig, 1 tab, 2 ref.

Descriptors: *Composting, *Land application, *Sludge disposal, *Austin, *Texas, Activated sludge, Sludge drying, Wastewater treatment,

Marketing, Pollutants, Fertilizers, Soil amendments, Sludge utilization.

The history and background and current sludge reuse program (land application and composting) at the Hornsby Bend Wastewater Treatment Facility (WWTF) of the city of Austin, Texas, are discussed. Austin has experienced rapid growth over the last decade, leading to a significant wastewater sludge treatment and disposal requirement. Approximately 50-54.4 dry metric tons of waste activated sludge are pumped daily from three remote WWTFs to the Hornsby Bend WWTF. Rather than using landfilling, lagooning, or incineration, the decision was made to approach the ultimate disposal problem as a potential resource by recycling stabilized sludge products combining land application and composting in a new beneficial reuse program. Dried anaerobically digested sludge and composted sludge are the two stabilized sludge products being produced at Hornsby Bend. The dried sludge is land applied as a soil conditioner and fertilizer in an agricultural program and the composted sludge is used in an 'uncontrolled use' program. The city of Austin sludge is relatively free of industrial pollutants, being far below the Texas Department of Health standards for Cd, Cu, Ni, Pb, Zn, and polychlorinated biphenyls for an uncontrolled use program. So far composted sludge has been used only by city departments, but marketing of the final product to the general public is planned. This beneficial reuse program has a promising future because there is a high demand for nutrient-rich soil conditioners in the Austin area due to poor local soil conditions. Having two sludge products for different end-users gives the program the flexibility to effectively prevent a sludge inventory problem during all seasons of the year. (See also W89-04782) (Rochester-PTT)
W89-04796

FULL SCALE PILOT RESULTS: COMPOSTING WASTEWATER SLUDGES USING AGITATED-BED SYSTEM,
International Process Systems, Inc., Lebanon, CT.
For primary bibliographic entry see Field 5D.
W89-04797

AKRON SLUDGE COMPOSTING FACILITY,
Akron Composting Facility, OH.
For primary bibliographic entry see Field 5D.
W89-04798

HAMPTON ROADS SANITATION DISTRICT'S COMPOST MARKETING PROGRAM,
Hampton Roads Sanitation District, Norfolk, VA.
R. L. Oberst.
IN: Analytical Techniques and Residuals Management in Water Pollution Control Specialty Conference April 19-20, 1988. Water Pollution Control Federation, Alexandria, VA 22314-1994. p 21-29, 2 fig, 2 tab.

Descriptors: *Composting, *Wastewater treatment, *Marketing, *Sludge disposal, *Hampton Roads, *Virginia, Performance evaluation, Cost analysis, Filtration, Nutri-Green, Operating costs.

Municipal sludge composting can be a successful sludge management tool. The success of such an operation depends on two things (1) the quality of the product and (2) the marketing program. The marketing program for the Hampton Roads Sanitation District, which produces a high-quality compost product, Nutri-Green, has been successful in marketing the product for the past several years. The initial composting distribution and marketing efforts, the compost sales program, and the full-time marketing scheme are described, including determination of target markets, product name recognition, distribution, pricing, and promotion. Marketing was treated as a full-time job and a comprehensive marketing plan was used. As a result of these efforts, the amount of compost sold went from less than 0.25 cu yd/day in 1982 to almost 13 cu yd/day in 1987. For the past three years more compost has been sold than was produced by the Hampton Roads facility. Because of revenues from compost sales, net operating costs have declined steadily since 1982. (See also W89-04782) (Rochester-PTT)
W89-04799

NATIONWIDE SURVEY OF COMPOSTING FACILITIES,
BioCycle, Emmaus, PA.
For primary bibliographic entry see Field 5D.
W89-04800

EPA'S SLUDGE PERMIT PROGRAM,
Environmental Protection Agency, Washington, DC. Office of Water Enforcement and Permits.
M. Kirkpatrick, and D. Clovis.
IN: Analytical Techniques and Residuals Management in Water Pollution Control Specialty Conference April 19-20, 1988. Water Pollution Control Federation, Alexandria, VA 22314-1994. p 37-44.

Descriptors: *Sludge disposal, *Wastewater treatment, *Permits, *Clean Water Act, *Environmental Protection Agency, Public health, Standards, Administrative regulations.

Amendments to Section 405 of the Clean Water Act require that permits issued to publicly-owned treatment works (POTWs) contain conditions to protect public health and the environment from pollutants in sewage sludge. These conditions are to consist of sludge standards when promulgated and, prior to that time, conditions developed on a case-by-case basis. The amendments have initiated a federal permit program to protect the environment from contaminated sludge and to encourage the beneficial reuse of uncontaminated sludge through permits issued either by EPA or the states. Development of the sludge program by EPA will be done as much as possible by building on existing federal permit programs and state sludge programs. In the immediate future, a primary focus will be on identifying sludge use or disposal problems requiring immediate attention, and on developing case-by-case requirements for permits issued to those facilities that are most likely to be a threat to the public health or environment. (See also W89-0484782) (Author's abstract)
W89-04801

MASSACHUSETTS WATER RESOURCES AUTHORITY: INTERIM SLUDGE MANAGEMENT PROGRAM,
Massachusetts Water Resources Authority, Boston, MA. Residuals Management Program.
M. Thomas, R. Trubiano, and S. Nostrand.
IN: Analytical Techniques and Residuals Management in Water Pollution Control Specialty Conference April 19-20, 1988. Water Pollution Control Federation, Alexandria, VA 22314-1994. p 45-58.

Descriptors: *Massachusetts, *Boston Harbor, *Sludge disposal, *Composting, Wastewater treatment, Regional planning, Management planning, Contracts, Sludge drying, Sludge transport, Privatization.

The Massachusetts Water Resources Authority (MWRA), is responsible (among other duties) for cleaning up Boston Harbor. The historical background, program objectives, procurement process, a summary of proposals for sludge management, committee review procedures and recommendations, and negotiation activities, and the characteristics of the chosen system are covered. The features and economic impact of proposals submitted by different contractors for sludge management were compared. Ultimately, one was chosen, with a contract covering professional services for planning, environmental review, and design activities for a sludge storage and dewatering and drying/pelletizing system in part I. Following this phase, the MWRA will publicly bid, construct, and subsequently own all the facilities. In part II of the contract, another contractor will operate the sludge transport and processing operation. Specifically, this will include barging and dewatering 100% of the sludge, receiving at least 60% of the cake for drying/pelletizing in the first year and 40% thereafter, with an option to accept 100%. MWRA will compost some of the sludge cake if it is not all taken by the contractor. In similar 'privatization' activities, it is suggested that treatment works should: (1) have detailed requests for proposals or bid documents; (2) employ a multi-step procurement process; (3) use a multidisciplinary evaluation and selection team; and (4) consider carefully the amount of risk to be accepted by the contractor versus the risk to be accepted by the municipality. (See also W89-04782) (Rochester-PTT)
W89-04802

MILWAUKEE'S SLUDGE REUSE PROGRAM: A DECADE OF GROWTH AND SUCCESS,
Milwaukee Metropolitan Sewerage District, WI.
D. J. Landis, P. Schlect, and G. Williamson.
IN: Analytical Techniques and Residuals Management in Water Pollution Control Specialty Conference April 19-20, 1988. Water Pollution Control Federation, Alexandria, VA 22314-1994. p 59-74, 2 fig, 3 tab.

Descriptors: *Sludge utilization, *Wisconsin, *Milwaukee, *Sludge disposal, *Land application, *Process control, Optimization, Cost analysis, Milorganite, Agri-Life, Marketing, Pricing, Public relations, Wastewater treatment.

The Milwaukee Metropolitan Sewerage District (MMSD) took action to establish a liquid sludge land application program, overcome the program's initial negative public reception, and provide a quality sludge product and customer service. The sludge program began in 1975 and developed into the AGRI-LIFE program; in 1984-1987 several management and staffing changes were made and the equipment base was expanded and improved using a $2 million EPA grant. A public relations program was developed to increase public awareness and counter a small amount of negative publicity generated by speculative newspaper accounts. When, in 1980, it was recognized that the Milorganite program operated at one MMSD plant was a $6 million revenue product whereas AGRI-LIFE was still costly, it was decided to treat the whole system as one industrial complex. Using this approach, unsold AGRI-LIFE was used to make Milorganite, generating an additional $6 million in gross revenue. In 1987, due to a reduction in the supply of AGRI-LIFE through successful implementation of the industrial complex, combined with a sustained three-year record of no application violations, no accidents, and a strong public relations effort, MMSD was able to implement a $6.50/acre charge for AGRI-LIFE product fertilizer value and services generating $12,000 of revenue; charges will be increased to $7.50/acre in 1988. (See also W89-04782) (Rochester-PTT)
W89-04803

CLAYTON COUNTY'S SLUDGE MANAGEMENT FACILITIES,
Clayton County Water Authority, Morrow, GA.
For primary bibliographic entry see Field 5D.
W89-04804

EMERGING SLUDGE MANAGEMENT TECHNOLOGIES,
Tulane Univ., New Orleans, LA. Dept. of Environmental Health Sciences.
For primary bibliographic entry see Field 5D.
W89-04805

ALKALINE STABILIZATION AND DISINFECTION OF MUNICIPAL WASTEWATER SLUDGE IN TOLEDO, OHIO: A CASE OF GOVERNMENTAL, BUSINESS AND ACADEMIC COOPERATION,
Medical Coll. of Ohio at Toledo. Dept. of Microbiology.
For primary bibliographic entry see Field 5D.
W89-04806

SIDE-BY-SIDE SLUDGE DEWATERING PERFORMANCE WITH FULL SCALE BELT FILTER PRESSES,
Memphis Wastetreatment Facilities, TN.
For primary bibliographic entry see Field 5D.

W89-04807

CITY OF TAMPA SLUDGE PELLETIZING PROJECT,
Hookers Point Advanced Wastewater Treatment Plant, Tampa, FL.
For primary bibliographic entry see Field 5D.
W89-04808

SEWAGE SLUDGE REUSE/DISPOSAL IN AN EVOLVING REGULATORY ATMOSPHERE: A CALIFORNIA PERSPECTIVE,
Carollo (John) Engineers, Walnut Creek, CA.
S. E. Stutz-McDonald.
IN: Analytical Techniques and Residuals Management in Water Pollution Control Specialty Conference April 19-20, 1988. Water Pollution Control Federation, Alexandria, VA 22314-1994. p 153-164, 7 fig, 2 tab, 3 ref.

Descriptors: *Sludge disposal, *Sludge utilization, *Management planning, *Wastewater treatment, *California, Regulations, Sludge conditioning, Land application, Sanitary landfills, Land disposal, Economic aspects.

The development of sludge management plans is discussed, with emphasis on how the regulations play a role in sludge reuse/disposal. Regulations at the federal level and in California (Department of Health Services and Water Resources Control Board) are reviewed; classification of sludge is discussed; treatment and dewatering processes are compared; and reuse/disposal alternatives are described (agricultural land spreading, dedicated land disposal, landfill/reuse disposal -using sludge to cover a landfill on a daily basis-, and composting and marketing). A flexible sludge management plan allows publicly-owned treatment works to tailor their reuse and disposal methods as the regulations change. As existing landfill capacity dwindles and stricter sludge regulations are enforced, sludge hauling distances may increase, and there will be significant benefits from producing drier sludges. (See also W89-04782) (Rochester-PTT)
W89-04809

REGIONAL SEPTAGE DISPOSAL IN SOUTHEASTERN CONNECTICUT,
Norwich Dept. of Public Utilities, CT.
G. Weaver.
IN: Analytical Techniques and Residuals Management in Water Pollution Control Specialty Conference April 19-20, 1988. Water Pollution Control Federation, Alexandria, VA 22314-1994. p 176-183.

Descriptors: *Septic tank wastes, *Septage, *Septic wastewater, *Wastewater treatment, *Sewage districts, *Connecticut, Norwich, Wastewater facilities, Management planning, Public participation, Economic aspects, Landfills, Leaching, Water pollution control.

The City of Norwich, Connecticut, investigated how it could use its wastewater treatment facility as a septage disposal station for its own use and that of 12 surrounding towns. The wastewater treatment facility was designed for an average daily flow of 8.5 mgd, but normally received 3.5 mgd from the city's collection system; with modifications, it could readily accept 30 or more truckloads/day of septage for disposal. To keep costs down, it was decided to bill the participating communities on a subscription basis, with the fee charged based on the number of unsewered properties. An obstacle to the plan developed when Norwich residents complained that the septage trucks passing through the city on the way to the wastewater treatment facility would be offensive. The solution to this problem was to extend sewerage to the Norwich landfill and make it the collection point, with the septage entering the wastewater treatment plant through the sewer system. A sewer main 3,500 ft long will be needed at a cost of $300,000. Benefits from this approach include: elimination of the traffic problem, using landfill staff to monitor the septage trucks to prevent illegal disposal of hazardous waste, use of the sewer to collect landfill leachate and thus solve a leaching problem at the landfill, and elimination of an existing problematical pump station used by one industry on the landfill site. (See also W89-04782) (Rochester-PTT)
W89-04811

EFFECTS OF SEWAGE SLUDGE ON LEACHATES AND GAS FROM SLUDGE-REFUSE LANDFILLS,
Environmental Protection Agency, Cincinnati, OH. Water Engineering Research Lab.
J. B. Farrell, G. K. Dotson, J. W. Stamm, and J. J. Walsh.
IN: Analytical Techniques and Residuals Management in Water Pollution Control Specialty Conference April 19-20, 1988. Water Pollution Control Federation, Alexandria, VA 22314-1994. p 184-216, 11 fig, 11 tab, 4 ref.

Descriptors: *Sludge disposal, *Leachates, *Landfills, *Path of pollutants, *Waste stabilization, Municipal wastewater, Wastewater analysis, Heavy metals, Pilot plants, Gas.

A 4-yr experiment has been completed on the effect of municipal wastewater sludge on leachate quality and gas production from simulated landfill test cells containing municipal solid waste. Addition of 10-30% by weight of a 16-percent-solids sludge cake to the solid waste caused the initiation of rapid anaerobic biological stabilization (RBS) in about 10 mo. Solid waste test cells not containing sludge required about 30 mo before the onset of RBS. During the 20-mo interim, the test cells containing sludge produced leachates containing about 1500 mg/L COD compared to values averaging 30,000 mg/L for the test cells without sludge. Heavy metal concentrations (Cd, Cr, Pb, Ni, Fe, Zn) in the leachage were generally lower initially in the cells containing sludge but after 4 yr were about the same as for the cells lacking sludge. (See also W89-04782) (Author's abstract)
W89-04812

CASE STUDY OF AGRONOMIC LAND APPLICATION OF SLUDGE,
Black and Veatch, Inc., Cambridge, MA.
J. S. Carr, M. E. Lang, W. J. Martin, and R. J. Tardy.
IN: Analytical Techniques and Residuals Management in Water Pollution Control Specialty Conference April 19-20, 1988. Water Pollution Control Federation, Alexandria, VA 22314-1994. p 217-227, 5 tab, 7 ref.

Descriptors: *Land application, *Sludge disposal, *Denver, *Colorado, Sewage districts, Regulations, Environmental effects, Wheat, Corn, Sorghum, Nitrogen, Phosphorus, Potassium, Iron, Zinc, Soil amendments, Seasonal distribution, Cost analysis.

A case study is presented of the Metropolitan Denver (Colorado) Sewage District No. 1 (MDSD1) land application program, including: a history of MDSD1, regulatory requirements at the federal and state level, MDSD1 sludge quantity and characteristics, a description of land application operations and calculation of the sludge application rate, program costs, and environmental impact. Since 1979, MDSD1 has successfully land-applied anaerobically digested sludge to supply N and other nutrients (mainly P, K, Zn, and Fe) required for crop growth. Sludge is applied to agricultural land for the growth of dryland wheat and irrigated crops consisting of wheat, corn, and grain sorghum. The life of an application or the cumulative sludge loading is based on the sludge cadmium concentration. The agronomic land application program has proven to be a reliable and cost-effective method of sludge utilization. Although the program initially consisted of injection of liquid sludge, the operation has been expanded to include application and incorporation of dewatered sludge. By expanding to dewatered sludge application, MDSD1 has been able to apply sludge during the winter months. In addition to the increased flexibility afforded by the application of dewatered sludge, MDSD1 reduced the cost of its program by approximately $14 dry Mg ($13/dry ton), which in 1987 represented a total saved of about $300,000. (See also W89-04782) (Rochester-PTT)
W89-04813

LAND APPLICATION OF INCINERATOR ASH,
Minnesota Univ., St. Paul. Dept. of Soil Science.
C. Rosen, R. Polta, and T. King.
IN: Analytical Techniques and Residuals Management in Water Pollution Control Specialty Conference April 19-20, 1988. Water Pollution Control Federation, Alexandria, VA 22314-1994. p 228-245, 19 tab, 13 ref.

Descriptors: *Sludge disposal, *Ash disposal, *Land application, *Soil amendments, *Minnesota, *Minneapolis, *Saint Paul, Chemical anaiysis, Corn, Crop yield, Phosphates, Zinc, Incineration, Tissue analysis, Data collections, Fertilizers.

A study was conducted to see whether sewage sludge ash could be used as a soil amendment/fertilizer without lowering crop quality or polluting the environment. Ash from the Metropolitan Water Commission of Minneapolis/St. Paul, Minnesota, was applied to a sandy loam soil at the Rosholt Research Farm, Westport, Minnesota. Treatments consisted of a control, three rates of superphosphate fertilizer (35, 70, and 140 kg/ha) and three equivalent rates of sewage sludge incinerator ash based on available phosphate (citrate method). Field corn was planted at a density of 79,000 plants/ha in 0.75-m rows. No differences in corn yields due to the treatments were detected, but the results did show that the ash treatments were not detrimental to yield or quality in the short term. Tissue analysis results showed that phosphate availability at equivalent rates did not appear to be as good from the ash source as from the fertilizer source. This may be due to lower P solubility in the ash compared to the fertilizer. Ash also appeared to be a good source of Zn, a nutrient which can be limiting when high rates of P fertilizer are used. Further experiments on this same site are required to evaluate longer-term effects of incinerator ash on element movement in the soil profile and effects on element uptake and yield response by the crop. (See also W89-04782) (Rochester-PTT)
W89-04814

LAND APPLICATION OF KODAK COLORADO DIVISION WASTEWATER TREATMENT PLANT SLUDGE,
Eastman Kodak Co., Windsor, CO. Kodak Colorado Div.
C. H. King, C. P. Houck, and L. L. Deadmond.
IN: Analytical Techniques and Residuals Management in Water Pollution Control Specialty Conference April 19-20, 1988. Water Pollution Control Federation, Alexandria, VA 22314-1994. p 246-261, 7 tab, 5 ref.

Descriptors: *Land application, *Sludge disposal, *Industrial wastewater, *Wastewater treatment, *Colorado, *Photographic wastes, Sludge injection, Monitoring, Management planning, Corn, Sugar beets, Beans, Barley, Aluminum, Silver, Heavy metals, Soil structure, Regulations, Soil contamination, Prediction, Pollution load, Crop yields.

Kodak Colorado Division (KCD) began incorporating sludge on cropland in 1977. A Briscoe-Maphis sludge injection system was used to apply sludge from the KCD industrial wastewater treatment plant twice a year to cropland. The success of the program, results of monitoring, and recent modifications to the program to meet regulatory requirements are discussed. The annual sludge application rate is normally 500-700 dry tons, with approximately 250 tons applied in the spring and 350 tons applied in the fall. The crops grown on the KCD agricultural fields have been primarily corn, sugar beets, beans, and barley. Silage corn has been the favored crop for use on the sludge incorporation fields, with yields ranging from 22 to 32 tons/acre. The sludge from the KCD plant is low in trace metals. It is similar to domestic sludge except that it contains some metals, such as aluminum and silver, in somewhat higher concentrations than domestic sludge. It has a lower organic con-

tent that digested, municipal sludge, and it contains no pathogens. The electroconductivity of the soil has increased and so have the contents of silver and copper as well as calcium, magnesium, and sodium. Soil structure also has changed. A long-range incorporation plan has been developed for KCD sludge; it incorporates regulatory requirements, incorporation site, operational alternatives, predictive plots, and monitoring and sampling (sludge, soils, crops, and groundwater). The sludge incorporation program described here represents a viable means of disposing of industrial sludge in an environmentally safe manner. A management program involving crop rotation adds humus to the soil, improving the soil's capability to hold water and reducing it dusting potential. Predictive plots can be used to determine an appropriate upper cumulative loading limit. (See also W89-04782) (Rochester-PTT)
W89-04815

SYNTHESIS OF THE RESULTS OF THE FIELD VERIFICATION PROGRAM UPLAND DISPOSAL ALTERNATIVE,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Effects Lab.
For primary bibliographic entry see Field 5B.
W89-04853

SUMMARY OF THE US ARMY CORPS OF ENGINEERS/US ENVIRONMENTAL PROTECTION AGENCY FIELD VERIFICATION PROGRAM,
Battelle Ocean Sciences, Duxbury, MA.
R. K. Peddicord.
Available from the National Technical Information Service, Springfield, VA 22161. Technical Report D-88-6, October 1988. Final Report. 52p, 3 fig, 23 ref, append.

Descriptors: *Spoil disposal, *Interagency cooperation, *Dredge spoil disposal, *Waste disposal, *Field tests, *Dredging, *Environmental effects, *Water pollution effects, Land disposal, Wetlands, Ocean dumping, Water quality, Toxicity, Bioaccumulation, Bioassay.

The US Army Corps of Engineers/US EPA Field Verification Program was a 6-year, $7.2 million study of upland disposal, wetland creation, and aquatic disposal with dredged material. The program was designed to determine: (a) the reproducibility of test methods in the laboratory; (b) the ability of laboratory test methods to predict effects in the field; and (C) the comparative effects of the same material in upland, wetland, and aquatic environments. The program demonstrated that effluent and surface water quality prediction methods have good utility for predisposal evaluation of dredged material proposed for upland disposal. Methods for testing toxicity and bioaccumulation in wetland plants showed good predictive ability. However, optimum utility for predictive evaluations of the upland and wetland animal bioassays awaits further confirmation of the reproducibility of the test results in the laboratory. Methods with good utility for evaluating dredged material proposed for aquatic disposal include toxicity, bioaccumulation, intrinsic rate of population growth, and scope for growth. Upland disposal produced the greatest and most persistent impacts. Wetland creation produced considerably less impact, and aquatic disposal gave relatively minor and nonpersistent impacts. This is in keeping with the physicochemical behavior of dredged material in these different environments. A similar ranking of effects would be expected in the disposal of other contaminated estuarine dredged material. (Author's abstract)
W89-04854

SYNTHESIS OF RESEARCH RESULTS: APPLICABILITY AND FIELD VERIFICATION OF PREDICTIVE METHODOLOGIES FOR AQUATIC DREDGED MATERIAL DISPOSAL,
Environmental Research Lab., Narragansett, RI.
J. H. Gentile, G. G. Pesch, J. Lake, P. P. Yevich, and G. Zaroogian.
Available from the National Technical Information Service, Springfield, VA 22161. Technical Report D-88-5, September 1988. Final Report. 72p, 16 fig, 6 tab, 47 ref.

Descriptors: *Spoil disposal, *Dredge spoil disposal, *Dredging, *Waste disposal, *Water pollution effects, *Waste management, Ocean dumping, Wetlands, Bioaccumulation, Data acquisition, Toxicity, Benthic environment, Ecological effects.

The Field Verification Program was designed to determine the applicability, reproducibility, and field verification of test methods for the evaluation of disposal of dredged material at aquatic, upland, and wetland sites. There were three objectives in this program. The first, to demonstrate the applicability of existing test variability and reproducibility inherent in the testing procedures. The second objective, to field verify the laboratory responses by comparing the exposure-response relationships between the laboratory and field. The third objective was to determine the degree of correlation between contaminated tissue residues and biological responses resulting from laboratory and field exposure to dredged material. These objectives were examined for the following biological responses: bioaccumulation, scope for growth, bioenergetics, adenylate energy charge, sister chromatid exchange, histopathology, survival, growth, reproduction, intrinsic rates of population growth, recolonization, and community structure. Survival in 11 aquatic species representing four phyla was determined for exposure to Black Rock Harbor, Connecticut, bedded and suspended sediments as part of initial sediment characterization studies. The following recommendations are made regarding the application of the test methods in this study for dredged material evaluation: (a) measures of survival, growth, reproduction, population, scope for growth, and contaminant bioaccumulation are recommended in the predisposal evaluation of dredged material; (b) while a genotoxic test method is desirable in the predisposal evaluation, sister chromatid exchange is not recommended pending further development of the test method; c) acceptable methods for postdisposal field bioenergetics and bioaccumulation in Nepthys incisa; (d) It is suggested that a rapid reconnaissance technique be used for species classification and enumeration for definitive assessments. (Lantz-PTT)
W89-04855

ACID DEPOSITION PRECURSOR CONTROL TECHNOLOGIES,
For primary bibliographic entry see Field 5B.
W89-04868

WASTE MINIMIZATION: HAZARDOUS AND NON-HAZARDOUS SOLID WASTE (1980 TO PRESENT).
Environmental Protection Agency, Washington, DC. Information Resources and Services Branch.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-163787. Price codes: A06 in paper copy, A01 in microfiche. Bibliographaic Series. Report No. EPA/IMSD-87-007, September 1987. 184p.

Descriptors: *Waste disposal, *Hazardous wastes, *Solid wastes, *Bibliographies, Oil, Recycling, Waste recovery, Regulations.

The bibliography was compiled with assistance from EPA's Office of Solid Waste in support of the overall Agency strategy to promote waste minimization and to improve access to current source reduction and recycling information. The bibliography, which also reflects current interest in used oil, includes citations from journal articles, books, government reports and bibliographies, conference proceedings, scientific and technical papers, and speeches. Citations were selected for their relevance to EPA information needs. The bibliography is divided into sections on Hazardous Waste, Used Oil, and Non-Hazardous Solid Waste. There are five appendices that provide sources of additional information: State Programs Supporting Waste Minimization; EPA Regional Waste Minimization Contacts; Associations; Waste Exchanges; and Recycling Periodicals. Most categories include citations from 1980 to the present. (Lantz-PTT)
W89-04880

LABORATORY PROTOCOL FOR DETERMINING FATE OF WASTE DISPOSED IN DEEP WELLS,
National Inst. for Petroleum and Energy Research, Bartlesville, OK.
For primary bibliographic entry see Field 5B.
W89-04897

USE OF ANILINE AS AN INDICATOR OF PERSISTENCE IN ENVIRONMENTAL STUDIES,
Lilly (Eli) and Co., Indianapolis, IN. Lilly Research Lab.
For primary bibliographic entry see Field 5A.
W89-05005

INFLUENCE OF UV RADIATION ON ORGANIC MATTER TRANSFORMATION AND SUBSEQUENT ALTERATION OF LEACHING AND TRANSPORT PROCESSES OF HEAVY METALS,
Rome Univ. (Italy). Dept. of Chemistry.
For primary bibliographic entry see Field 5B.
W89-05009

LEACHING BEHAVIOR OF SELECTED TRACE ELEMENTS IN CHEMICALLY WEATHERED ALKALINE FLY ASH,
Alberta Univ., Edmonton. Dept. of Soil Science.
For primary bibliographic entry see Field 5B.
W89-05018

TEST FOR DREDGED MATERIAL EFFLUENT QUALITY,
Waterways Experiment Station, Vicksburg, MS.
For primary bibliographic entry see Field 5A.
W89-05222

CONTROL OF VOC EMISSIONS FROM WASTE MANAGEMENT FACILITIES,
New York State Dept. of Environmental Conservation, Albany.
T. T. Shen, and G. H. Sewell.
Journal of Environmental Engineering JOEDDU, Vol. 114, No. 6, p 1392-1400, December 1988. 1 tab, 22 ref.

Descriptors: *Fate of pollutants, *Air pollution, *Volatile acids, *Organic compounds, *Waste management, Waste recovery, Waste storage, Waste treatment, Waste disposal, Comparison studies.

Concerns with emissions of volatile organic compounds (VOC) from waste treatment, storage, and disposal facilities are increasing because of the emission quantity (1,600,000 to 5,000,000 metric tons per year) and toxicity and/or carcinogenicity. The sources of VOC emissions include impoundments and tanks, land treatment, landfills and waste piles, transfer and handling operations, and VOC removal devices. No regulation exists to control VOC emissions from those waste management facilities. This paper reviews the problems of VOC emissions from treatment, storage, and disposal facilities. It also examines the inherent effectiveness of control techniques for VOC emissions from such facilities. Conventional pollution control approaches focus on pretreatment, in situ methods, and postreatment of wastes after generation. Such approaches have achieved some success, but they are expensive to implement and not 100% efficient, and may transfer VOCs from one physical form to another and from one environmental medium to another, causing secondary pollution. A waste minimization strategy reduces waste generation at its source and it can save costs for waste treatment, storage, transport, disposal, regulatory compliance, and future liabilities. The objective of this paper is to compare the feasibility and desirability of minimizing waste VOCs before generation with alternative strategies and techniques that are now being used or proposed. It has been shown that waste minimization is feasible and cost-effective in many process industries. Typical successful examples of waste-solvent minimization are presented including paint companies, printing industries, solvent leas-

ing services, and the Los Angeles County Rule 66. (Author's abstract)
W89-05229

LEAKAGE RATES THROUGH FLAWS IN MEMBRANE LINERS,
Texas A and M Univ., College Station. Dept. of Civil Engineering.
P. W. Jayawickrama, K. W. Brown, and R. L. Lytton.
Journal of Environmental Engineering JOEDDU, Vol. 114, No. 6, p 1401-1420, December 1988. 5 fib, 3 tab, 10 ref. EPA Cooperative Agreement CR 810940.

Descriptors: *Leakage, *Impervious membranes, *Reservoir linings, *Seepage loss, *Landfills, *Wastedumps, *Water pollution sources, Flaws, Effluent seepage, Simulation, Leaky boundaries, Infiltration, Soil contamination.

A detailed experimental and theoretical study was undertaken to evaluate the leak rate of liquids through flaws in synthetic flexible membrane liners (FMLs) into a compacted soil subbase. In the experimental phase of the research study a series of large scale laboratory permeameter tests were performed to determine the influence of the various factors on the leakage rate of water. The parameters examined included the water head above the FML, the hydraulic conductivity of the subbase material, the size and shape of the flaw, and the type and thickness of the FML. The results revealed that the liquid spreads laterally along a gap between the liner and the subsoil, with simultaneous infiltration into the soil. In the analytical phase of the study, a model was developed to simulate these flow mechanisms. Subsequently, the calibrated model was used to prepare a set of tables and graphs which may be used to predict potential leak rates in field installations. (Author's abstract)
W89-05230

OPTIMAL SAMPLING OF DOMESTIC SOLID WASTE,
Asian Development Bank, Manila (Philippines). Environmental Unit.
For primary bibliographic entry see Field 7B.
W89-05235

INFLUENCE OF HUMIC ACID ON THE TOXICITY AND BIOAVAILABILITY OF SELECTED TRACE METALS,
Northeast Louisiana Univ., Monroe. Toxicology Program.
For primary bibliographic entry see Field 5B.
W89-05312

SAFE HANDLING AND DISPOSAL OF CHLORINATED SOLVENT WASTE AND RESIDUE,
Conseil Europeen des Federation de l'Industrie Chimique, Brussels (Belgium).
P. Herbert, F. Van Mensch, P. Carbonnier, K. Beutel, and C. de Rooij.
Chemistry and Industry CHINAG, Vol. 15, p 522-525, August 1988. 1 fig, 1 tab.

Descriptors: *Toxic wastes, *Hazardous wastes, *Chlorinated hydrocarbons, *Solvents, *Waste disposal, *Industrial wastes, *Waste management, *Water pollution control, *Chemical wastes, Governmental interrelations, Incineration, Regulations, Landfills, Groundwater pollution, European Economic Community, Recycling, Water quality control.

Various aspects of the management of solvent and waste residues are discussed, including sources, waste prevention and disposal, storage, packaging, labelling, transport, and disposal regulations for member nations of the European Economic Community. The best way to reduce the amounts of chlorinated solvent waste is to re-use the solvent as many times as possible either by in-house recovery or recovery by a reputable licensed contractor. Landfill is used for solvent waste in solid form or as a sludge or paste, however it has been prohibited in several EEC countries due to lack of proper control leading to groundwater pollution. Almost all solvent wastes are now ultimately incinerated, under carefully controlled conditions at temperatures above 1000 C, with sufficient air present so that the final products are hydrochloric acid, carbon dioxide and water. The hydrochloric acid is normally scrubbed out and may be re-utilized or neutralized. Drums, or containers should be clearly labelled to prevent confusion with fresh solvent or any other products. Reference should be made to the safety data supplied by the manufacturer of the solvent. (Friedmann-PTT)
W89-05329

DREDGED MATERIAL DISPOSAL MODELING IN PUGET SOUND,
Waterways Experiment Station, Vicksburg, MS.
B. H. Johnson, M. J. Trawle, and S. A. Adamec.
Journal of Waterway, Port, Coastal and Ocean Engineering (ASCE) JWPED5, Vol. 114, No. 6, p 700-713, November 1988. 3 fig, 2 tab, 8 ref.

Descriptors: *Path of pollutants, *Model studies, *Dredging, *Ocean dumping, *Puget Sound, *Mathematical models, Sounds, Water currents, Water depth, Pipelines, Barges, Convection, Model testing, Fate of pollutants.

Results from a series of numerical model runs predicting the short-term physical fate of dredged material disposed in the open water of Puget Sound are presented along with a discussion of the numerical model applied. The first set of results is from a generic study covering a wide range of water depths and ambient currents. The range of conditions tested is intended to represent typical ambient conditions and material to be disposed in Puget Sound. The second set of results is from a study concerning the modeling of the fate of material to be dredged at the proposed U.S. Navy Home Port in Everett, WA. Current plans call for disposal of the material at a site located in 81 m of water in Puget Sound. The approach under study is to dispose of the contaminated material from a bottom-dumping barge to be capped by the following disposal of uncontaminated material from a surface pipeline with an attached splash plate to minimize the bottom impact of the capping material. (Author's abstract)
W89-05345

ENGINEERING/COST EVALUATION OF OPTIONS FOR REMOVAL/DISPOSAL OF NC FINES,
Little (Arthur D.), Inc., Cambridge, MA.
For primary bibliographic entry see Field 5D.
W89-05395

CHRONIC HYDROCARBON DISCHARGES INTO AQUATIC ENVIRONMENTS: I. MUNICIPAL TREATMENT FACILITIES,
Rhode Island Univ., Narragansett. Graduate School of Oceanography.
For primary bibliographic entry see Field 5D.
W89-05439

CHEMISTRY AND BIOLOGY OF SOLID WASTE: DREDGED MATERIAL AND MINE TAILINGS.
Springer-Verlag, New York, NY. 1988. 305p. Edited by W. Salomons and U. Forstner.

Descriptors: *Waste disposal, *Water chemistry, *Water pollution sources, *Solid wastes, *Solid waste disposal, *Dredging, *Mine wastes, *Acid mine drainage, *Mine drainage, Biology, Chemistry, Spoil banks, Geochemistry.

Mine tailings and dredged materials are solid wastes, which are produced at single sites in huge quantities. Mine tailings, compared to the more recent environmental implications with dredged materials, have been recognized as problematic materials for a long time. A major part of mineral reserves are in less-developed countries, and a disproportionate fraction of resource development is expected to take place in areas where environmental protection measures may be limited. As a result of this situation: (1) reclamation should be carried out during the life of the mine; (2) technology to ameliorate long-term effects should be as self-supporting as possible; (3) simple, reliable, low-energy techniques for minimizing deleterious effects of mining should be developed. (See W89-05556 thru W89-05567) (White-Reimer-PTT)
W89-05555

MICROBIOLOGICAL OXIDATIONS OF MINERALS IN MINE TAILINGS,
Biotechnology Australia Pty Ltd., Roseville (Australia).
For primary bibliographic entry see Field 5B.
W89-05557

RESPONSE OF PLANTS AND VEGETATION TO MINE TAILINGS AND DREDGED MATERIALS,
Vrije Univ., Amsterdam (Netherlands). Dept. of Ecology and Ecotoxicology.
For primary bibliographic entry see Field 5C.
W89-05558

DEVELOPMENT OF DREDGED MATERIAL DISPOSAL SITES: IMPLICATIONS FOR SOIL, FLORA AND FOOD QUALITY,
Institute for Soil Fertility, Haren (Netherlands).
For primary bibliographic entry see Field 5B.
W89-05560

BIOLOGICAL ASSESSMENT OF ENVIRONMENTAL IMPACT OF DREDGED MATERIAL,
Technische Univ. Hamburg-Harburg (Germany, F.R.). Arbeitsbereich Umweltschutztechnik.
For primary bibliographic entry see Field 5C.
W89-05561

GEOCHEMISTRY OF PRIORITY POLLUTANTS IN ANOXIC SLUDGES: CADMIUM, ARSENIC, METHYL MERCURY, AND CHLORINATED ORGANICS,
Technische Univ. Hamburg-Harburg (Germany, F.R.). Arbeitsbereich Umweltschutztechnik.
For primary bibliographic entry see Field 5B.
W89-05563

BEHAVIOUR OF TRACE METALS IN A TROPICAL RIVER SYSTEM AFFECTED BY MINING,
Bougainville Copper Ltd., Panguna (Papua New Guinea).
For primary bibliographic entry see Field 5B.
W89-05566

ENVIRONMENTAL MANAGEMENT OF SOLID WASTE: DREDGED MATERIAL AND MINE TAILINGS.
Springer-Verlag, New York, NY. 1988. 396p. Edited by W. Salomons and U. Forstner.

Descriptors: *Solid waste disposal, *Spoil banks, *Dredging, *Mine wastes, *Acid mine drainage, *Mine drainage, *Solid wastes, Environmental policy, Economic aspects, Biological properties, Geochemistry.

The problems and questions mine tailings and dredged materials pose with regard to safe environmental deposition are similar: aquatic versus terrestrial disposal, revegetation, leaching of contaminants. Larger projects in the fields of both mine tailings reclamation and dredged material disposal are increasingly requiring a multidisciplinary team approach. A major part of mineral reserves are in less-developed countries with limited environmental controls. Such experience implies far-going demands from the host countries: (1) Reclamation should be carried out, as far as possible, during the life of the mine; (2) technology to ameliorate long-term effects should be as self-supporting as possible; (3) simple, reliable, low-energy techniques for minimizing deleterious effects of mining should be developed. (See W89-05569 thru W89-05585) (White-Reimer-PTT)
W89-05568

METHODS FOR THE TREATMENT OF CONTAMINATED DREDGED SEDIMENTS,
Hoofdgroep Maatschappelijke Technologie TNO, Apeldoorn (Netherlands).
For primary bibliographic entry see Field 5D.
W89-05571

CLASSIFICATION AND DEWATERING OF SLUDGES,
Technische Univ. Hamburg-Harburg (Germany, F.R.).
For primary bibliographic entry see Field 5D.
W89-05572

STABILIZATION OF DREDGED MUD,
Technische Univ. Hamburg-Harburg (Germany, F.R.).
W. Calmano.
IN: Environmental Management of Solid Waste: Dredged Material and Mine Tailings. Springer-Verlag, New York, NY. 1988. p 80-98, 4 tab, 6 fig, 42 ref.

Descriptors: *Heavy metals, *Solid waste disposal, *Spoil banks, *Dredging, *Solid wastes, Borrow pits, Stabilization, Germany, Sulfides.

The deposition in an anoxic and sulfidic milieu seems to be a very efficient method to immobilize most heavy metals because of formation of very stabile metal sulfides. Such a milieu is found in the marine environment; however, deposits must be strictly isolated from the surrounding hydrosphere and biosphere. There are several projects in progress in which dredged material is deposited into submarine borrow pits and covered with clean sediments. Studies indicate these technological concepts are optimal (1) A location with a water depth between 2-5 m and a ground consisting of sand at least 25 m thick. (2) A site location in a morphologically stable area with low erosion potential by currents and wave forces. (3) Deposition into a previously dug hole which is sealed with uncontaminated material after completion of disposal. (5) The dredged material can be placed by spoiling or in partially dewatered form. The transport water must be recirculated and cleared off. (See also W89-05568) (White-Reimer-PTT)
W89-05573

INTEGRATED BIOLOGICAL SYSTEMS FOR EFFLUENT TREATMENT FROM MINE AND MILL TAILINGS,
Randol International Ltd., Golden, CO.
For primary bibliographic entry see Field 5D.
W89-05574

ECOLOGICAL ENGINEERING: BIOLOGICAL AND GEOCHEMICAL ASPECTS PHASE I EXPERIMENTS,
Boojum Research Ltd., Toronto (Ontario).
For primary bibliographic entry see Field 5G.
W89-05575

ROTTERDAM DREDGED MATERIAL: APPROACH TO HANDLING,
Municipality of Rotterdam (Netherlands).
J. P. J. Nijssen.
IN: Environmental Management of Solid Waste: Dredged Material and Mine Tailings. Springer-Verlag, New York, NY. 1988. p 243-281, 5 tab, 15 fig, 42 ref.

Descriptors: *Waste management, *Harbors, *Solid wastes, *Solid waste disposal, *Dredging, *Long-term planning, Economic aspects, Costs, Environmental policy, Environmental protection, Ocean dumping, Land disposal, Alternative planning, Decision making, The Netherlands, Planning.

In the Rhine estuarine region in which the city of Rotterdam, The Netherlands, is located, access for shipping must always be guaranteed. This necessitates continuous dredging of the fairways and harbors and every year approximately 23 million cubic M of sediment must be removed by maintenance dredging work. In 1979 a report was completed that investigated dredge disposal options in the sea, on land, and in deep ponds; and alternative ways of handling the material. A policy plan was then formulated. On the basis of a division into non-contaminated or lightly contaminated, contaminated and heavily contaminated classes, the dredged material is disposed of in the sea, at a large-scale site or at a specially designed site. In the case of the large-scale site the administrative decision was preceded by an extensive investigation into a number of alternative locations which were chosen in such a way that conflict was largely between economic and environmental interests. Variations in the costs of the various alternatives result from the differences in distances from the site, the measures enforced at the site, and the demands made with regard to the dredging work. The solutions presented are valid for a period of 15-20 years. A long-term policy is being formulated that includes the prevention of the creation of heavily contaminated dredged material and improvement in the quality of the dredged material. (See also W89-05568) (White-Reimer-PTT)
W89-05582

DECISION-MAKING FRAMEWORK FOR MANAGEMENT OF DREDGED MATERIAL DISPOSAL,
Army Engineer Waterways Experiment Station, Vicksburg, MS.
C. R. Lee, and R. K. Peddicord.
IN: Environmental Management of Solid Waste: Dredged Material and Mine Tailings. Springer-Verlag, New York, NY. 1988. p 324-371, 8 tab, 14 fig, 59 ref.

Descriptors: *Waste management, *Dredging, *Solid waste disposal, *Decision making, Solid wastes, Management planning, Economic aspects, Comprehensive planning, Alternative planning.

The selection of a disposal management strategy must consider the nature of the sediment to be dredged, potential environmental impacts of the disposal of the dredged material, nature and degree of contamination, dredging equipment, project size, site-specific conditions, technical feasibility, economics, and other socioeconomic factors. The management strategy consists of the following: (1) Initial evaluation to assess contamination potential; (2) selecting a potential disposal alternative; (3) identifying potential problems of each alternative; (4) testing to evaluate the problems; (5) assessing need for disposal restrictions; (6) selecting an implementation strategy; (7) identifying available control options; (8) examining design considerations to evaluate technical and economic feasibility; and (9) choosing appropriate control measures and technologies. A number of variations are presented for each of the major alternatives of open water and upland confined disposal, each having a significant influence on the fate of contaminants at disposal sites. The management strategy provides a framework for assessing and choosing an appropriate alternative for disposal based on specific problem areas. It is applicable to materials ranging from clean sand to highly contaminated sediments. (See also W89-05568) (White-Reimer-PTT)
W89-05584

TRACE ORGANICS AND INORGANICS IN DISTRIBUTION AND MARKETING MUNICIPAL SLUDGES,
Los Angeles County Sanitation Districts, Whittier, CA.
R. Baird, and S. M. Gabrielan.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-160585. Price codes: A10 in paper copy, A01 in microfiche. Report No. EPA/600/1-88/001, January 1988. 241p, 6 fig, 9 tab, 51 ref, 10 append. EPA Contract CR-812589-010.

Descriptors: *Land disposal, *Water pollution sources, *Sludge disposal, Fate of pollutants, Organic compounds, Inorganic compounds, Public health, Microbiological studies, Pollutant identification, Drinking water, Bioaccumulation, Solid wastes, Toxicity.

The land application of municipal wastewater treatment sludges is widely practiced both as an economic treatment method for disposal and to provide an economic soil nutrient amendment for agricultural use. Concerns over the general disposal of sludge to land have focused on several adverse impacts from sludge-borne chemical and microbiological agents, including phytotoxicity, domestic animal toxicity, and human health. Human health issues primarily emphasize whether these agents enter the food chain via: contamination of drinking water, accumulation in and on edible crops, and accumulation in animals and animal products used for food. The specific goals of this study were: (1) to provide a database of 15 trace metals and 121 toxic organic compounds in stabilized sludge products form 26 U.S. cities which are distributed and marketed for various land application uses, and (2) to characterize selected sludge extracts from each city for non-target organic chemicals which might predominate in individual sludges. Results from this study would help determine if certain distributed and marketed sludges, based on their chemical contents and concentration, should be treated as solid wastes to avoid adverse health risks to the general public. (Author's abstract)
W89-05766

GEOCHEMICAL MODELING RESEARCH RELATED TO THE SURFACE DISPOSAL OF PROCESSED OIL SHALE SOLID WASTE,
University of Wyoming Research Corp., Laramie. Western Research Inst.
K. J. Reddy, and J. I. Drever.
Available from the National Technical Information Service, Springfield, VA 22161, as DE88-003370. Price codes: A06 in paper copy, A01 in microfiche. Report No. DOE/MC/11076--2443, October 1987. 107p, 15 tab, 64 ref. DOE Contract DE-FC21-86MC11076.

Descriptors: *path of pollutants, *Water pollution control, *Geochemistry, *Model studies, *Land disposal, *Waste disposal, *Oil shale, Fate of pollutants, Chemical reactions, Solid wastes, Adsorption, Ion exchange, Thermodynamics, Strontium, Fluorine, Molybdenum, Selenium.

Several geochemical codes are available in the literature to model chemical processes such as oxidation-reduction, precipitation-dissolution, formation of solution complex, adsorption, and ion exchange. However, these models differ in the environments to which they apply. The objective of this research was to evaluate the applicability of existing geochemical codes to predict water quality from an oil shale solid waste environment. The EQ3/EQ6, GEOCHEM, MINTEQ, PHREEQE, SOLMNEQ, and WATEQFC geochemical models were selected for further evaluation. It is concluded that all these models lack thermodynamic data for minerals and solution complexes which are important for oil shale solid waste studies. Selection of any one of the models would require development of a more reliable thermodynamic database; the initiation of that work is described. So far, critical evaluation of thermodynamic data has been completed for Sr, F, Mo, and Se. (Author's abstract)
W89-05768

5F. Water Treatment and Quality Alteration

PUBLIC WATER SUPPLIES IN LOUISIANA. VOLUME 1: NORTHERN LOUISIANA,
Geological Survey, Baton Rouge, LA. Water Resources Div.
D. L. Lurry.
Louisiana Department of Transportation and Development, Baton Rouge, Water Resources Basic Records Report No. 13, 1985. 119p, 1 fig, 4 tab, 13 ref.

Descriptors: *Data collections, *Drinking water, *Water supply, Municipal water, Groundwater budget, Surface waters, Water quality, Hydrologic data, Well logs.

Information for 267 public water supplies, which include municipal systems, parish water districts, and most privately owned water districts in northern Louisiana is tabulated. Groundwater is the source of supply for 251 of these water systems and surface water is the source for 141. The remaining two systems are served by both groundwater and surface-water sources. The following information, if available, is given for each water system: owner, treatment procedures, source of supply, population, number of service connections, pumpage, and well logs; water quality information for selected wells and water systems are presented in tables. (Author's abstract)
W89-04657

THIRD CARIBBEAN ISLANDS WATER RESOURCES CONGRESS.
For primary bibliographic entry see Field 6A.
W89-04665

MODIFICATION OF WATER QUALITY IN IVUJIVIK (NORTHERN QUEBEC, CANADA),
Quebec Univ., Montreal.
For primary bibliographic entry see Field 5D.
W89-04720

DETERIORATION OF DRINKING WATER DISTRIBUTION SYSTEMS,
Environmental Protection Agency, Cincinnati, OH. Office of Research and Development.
J. A. Goodrich.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-159041. Price codes: A03 in paper copy, A01 in microfiche. Report No. EPA/600/D-88/007, January 1988. 28p, 16 fig, 1 tab, 8 ref.

Descriptors: *Water conveyance, *Drinking water, *Water quality, *Water distribution, Cost, Disease, Public health, Leakage, Pipes, Maintenance.

A frequently overlooked fact is the effect that the drinking water delivery system can have on the quality of water received at the tap. Deterioration of aging water supply systems can result in pipeline failures, pressure losses, fire hazards, damaged streets, human health concerns, and economic losses. The cumulative effects of inadequate maintenance and repair and a pipe's local environment can contribute to leakage losses of up to 40% and > 2 breaks/km/year. Twenty percent of the waterborne disease outbreaks in the United States have been associated with distribution system failures. Coupled with these water quality considerations is the fact that delivery systems can account for up to 80% of the cost of water supply. (Author's abstract)
W89-04751

REMOVAL OF CHROMIUM FROM ION EXCHANGE REGENERANT SOLUTION,
Houston, TX.
S. Siegel, and D. Clifford.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-158084. Price codes: A04 in paper copy, A01 in microfiche. Report No. EPA/600/2-83/007, January 1988. 61p, 16 fig, 13 tab, 34 ref, append.

Descriptors: *Water treatment, *Chromium, *Ion exchange, Chromate, Wells, Groundwater pollution, Sodium chloride, Sulfite, Hydrazine, Sludge digestion, Ferrous sulfate, Costs.

A pilot study in Scottsdale, AZ determined that chromate could be efficiently removed from groundwater using chloride form anion exchange resin. A typical run length exceeded 30 days after which the column could be regenerated with 3-5 bed volumes of 1 N (6%) NaCl. The purpose of the present study was to establish means of removing the chromate (Cr(VI)) from the spent regenerant solution, thus rendering it a non-toxic brine. In this bench-scale study, the Cr(VI) was reduced to Cr(III) and then precipitated as Cr(OH)3(s). Sulfite, hydrazine, and ferrous sulfate were tried as reductants. Sulfite and hydrazine operated best at pH < 2 while ferrous sulfate performed well in the neutral pH range. Sludges from all of the reduction processes settled well and settling was improved with increasing NaCl concentration. All three sludges passed the extraction procedure (EP) toxicity test when evaluated for chromium leachability. Ferrous sulfate reduction proved to be the lowest cost treatment method for the regenerant brine. For a 4 MGD treatment system utilizing 70% bypass flow and reducing the chromium from 0.,050 mg/L to 0.035 mg/L in the blended product water, the spent regenerant brine treatment cost was quite low -- $1.50/million gal of product water. For a 0.1 MGD treatment system, the corresponding cost was $460/million gal of product water. These estimates include only the costs for ferrous sulfate and Cr(OH)3 sludge landfilling. Pilot-scale studies and possible reuse are recommended before a full-scale system is designed. (Author's abstract)
W89-04841

COLIFORM NON-COMPLIANCE NIGHTMARES IN WATER SUPPLY DISTRIBUTION SYSTEMS,
Environmental Protection Agency, Cincinnati, OH. Drinking Water Research Div.
E. E. Geldreich.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-158936. Price codes: A03 in paper copy, A01 in microfiche. Report No. EPA/600/D-88/005, January 1988. 38p, 3 tab, 94 ref.

Descriptors: *Water supply systems, *Pipes, *Coliforms, Microbiological studies, Bacteria, Water temperature, Water treatment, Water quality.

Coliform occurrences in distribution systems have created a great concern for both utilities and Water Authorities because of the implied public health implications and failure to meet Federal Regulations. Many of the known cases involve systems in the east and midwest. The common denominator is systems that have significant amounts of pipe networks over 75 years old and all are treating surface waters. Origins for these contamination events can be found in source water fluctuations, failures in treatment barrier protection or loss of pipe network integrity. Once passage into the distribution network has been achieved, some of the coliforms (Klebsiella, Enterobacter, Citrobacter) and other heterotrophic bacteria adapt to the pipe environment, finding protection and nutrient support in pipe sediments. Under conditions of seasonal warm waters (10 C) and availability of assimilable organics in the pipe sediments and tubercles, colonization grows into biofilms that may slough-off into the water supply, creating a coliform non-compliance problem. Significance of these occurrences and control measures are part of a realistic action plan presented for guidance. (Author's abstract)
W89-04847

METHODS OF REMOVING URANIUM FROM DRINKING WATER.
Environmental Protection Agency, Washington, DC. Office of Drinking Water.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-120795. Price codes: A06 in paper copy, A01 in microfiche. Report No. EPA-570/9-82-003, December 1982. 89p.

Descriptors: *Water treatment, *Drinking water, *Uranium, *Literature review, *Municipal water, Potable water, Raw water, Chemical treatment, Adsorption, Titanium oxide, Activated charcoal.

Literature was searched for methods of removing uranium from drinking water. U.S. manufacturers and users of water treatment equipment and products were also contacted regarding methods of removing uranium from potable water. Based on the results of these surveys, it was recommended that untreated, partially treated, and finished water samples from municipal water treatment facilities be analyzed to determine the extent of removal of uranium by presently used procedures, and that additional laboratory studies be performed to determine what changes are needed to maximize the effectiveness of treatments that are already in use in existing water treatment plants. Uranium analyses of raw water, intermediate stage, and treated water samples from 20 municipal water treatment plants indicated that the present treatment practices were not effective in removing uranium from raw waters when the influent concentration was in the range of 0.1 to 16 micrograms/L uranium. Laboratory batch tests revealed that the water softening and coagulant chemicals commonly used were able to remove more that 90% of the dissolved uranium (< 100 micrograms/L) in waters if an optimum pH and dosage were provided. Adsorbents, titanium oxide and activated charcoal, were also effective in uranium removal under specific conditions. Strong base anion exchange resin was the most efficient uranium adsorbent, and an anion exchange column is a recommended option for the treatment of private well waters containing uranium at higher than desirable levels. (See W89-04859 thru W89-04860) (Author's abstract)
W89-04858

METHODS OF REMOVING URANIUM FROM DRINKING WATER: I. A LITERATURE SURVEY,
Oak Ridge National Lab., TN. Health and Environmental Studies Program.
J. S. Drury, D. Michelson, and J. T. Ensminger.
IN: Methods of Removing Uranium from Drinking Water. Report No. EPA-570/9-82-003, December 1982. p 1-36, 5 tab, 98 ref, 2 append.

Descriptors: *Water treatment, *Uranium, *Literature review, Chemical precipitation, Aluminum hydroxide, Ferric hydroxide, Activated carbon, Ion exchange, Chemical treatment, Municipal water.

Literature was searched for methods of removing uranium from drinking water. Just a few papers addressed the problem of removing uranium from natural fresh waters and established the effectiveness of using adsorbents or coprecipitants, such as aluminum hydroxide, ferric hydroxide, activated carbon, and ion exchangers, under certain conditions. Also, many U.S. manufacturers and users of water treatment equipment and products were contacted regarding recommended methods of removing uranium from potable water. Based on the results of these surveys, it is recommended that untreated, partially treated, and finished water samples from municipal water treatment facilities be analyzed to determine their extent of removal of uranium by presently used procedures. In addition, laboratory studies are suggested to determine what changes, if any, are needed to maximize the effectiveness of treatments that are already in use in existing water treatment plants. (See also W89-04858) (Lantz-PTT)
W89-04859

METHODS OF REMOVING URANIUM FROM DRINKING WATER: II. PRESENT MUNICIPAL WATER TREATMENT AND POTENTIAL REMOVAL METHODS,
Oak Ridge National Lab., TN. Environmental Sciences Div.
S. Y. Lee, S. K. White, and E. A. Bondietti.
IN: Methods of Removing Uranium from Drinking Water. Report No. EPA-570/9-82-003, December 1982. p 37-89, 7 fig, 23 tab, 16 ref, append.

Descriptors: *Uranium, *Drinking water, *Water treatment, *Municipal water, Raw water, Water softening, Chemical treatment, Coagulation, Titanium oxide, Activated carbon, Anion exchange, Adsorption.

Uranium analyses of raw water, intermediate stage, and treated water samples from 20 municipal water treatment plants indicated that the present treatment practices were not effective in removing uranium from raw waters when the influent concentration was in the range of 0.1 to 16 micrograms/L uranium. Laboratory batch tests revealed that the water softening and coagulant chemicals commonly used were able to remove more than 90% of the dissolved uranium (< 100 micrograms/L) in waters if an optimum pH and dosage were provided. Absorbents, titanium oxide and activated

carbon, were also effective in uranium removal under specific conditions. Strong base anion exchange resin was the most efficient uranium adsorbent, and an anion exchange column is a recommended option for the treatment of private well waters containing uranium at higher than desirable levels. (Author's abstract)
W89-04860

TOTAL EXPOSURE AND RISK ASSESSMENT FOR DRINKING WATER CONTAMINATED WITH VOLATILE ORGANIC COMPOUNDS,
Illinois Univ. at the Medical Center, Chicago. School of Public Health.
For primary bibliographic entry see Field 5C.
W89-04884

STATISTICAL ANALYSIS RELATING WELL YIELD TO CONSTRUCTION PRACTICES AND SITING OF WELLS IN THE PIEDMONT AND BLUE RIDGE PROVINCES OF NORTH CAROLINA,
Geological Survey, Raleigh, NC. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-04914

WATER SUPPLIES IN WESTERN KENTUCKY DURING 1984,
Geological Survey, Louisville, KY. Water Resources Div.
C. J. Sholar, and P. A. Wood.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, Co 80225. USGS Water Resources Investigations Report 86-4171. 1986. 89p, 17 fig, 32 tab, 17 ref.

Descriptors: *Water resources data, *Water use, *Kentucky, *Water supply, *Water treatment facilities, Municipal water, Industrial water, Water permits, Available water, Groundwater availability, Surface water availability.

An inventory was conducted between April and October 1985 of 101 major public supply systems and of self-supplied commercial and industrial water systems in a 27-county area in western Kentucky. These systems, because they withdraw at least 10,000 gal/day (gpd), are regulated by the Kentucky Natural Resources and Environmental Projection Cabinet (Division of Water) through a permitting program. The major purpose of the inventory was to evaluate the adequacy of these water systems to meet demands during times of drought. The inventory indicated that these systems withdrew 116.3 million gpd in 1984. The study showed that public facilities supplied 33.1 mil gpd to 471,500 people. Bowling Green Municipal Utilities in the Green River basin was the largest single public supplier. It supplied 5.05 million gpd to 48,000 people, and also sold over 1.7 million gpd to about 30,000 people through the Warren County Water System. Comparisons of ground- and surface-water use indicated the Lower Ohio River basin had the highest percentage of surface-water use at 97%, and the Mississippi River basin had the highest percentage of groundwater use at 41%. Sources of water were generally adequate throughout the study area. Sources for two industries, also in the Green River basin, are inadequate. Six systems may have potential problems with their treatment plant capacities because they are operating at > 80% of design capacity. Three of these systems are in the Green River basin, two are in the Lower Cumberland River basin, and one is in the Tennessee River basin. (Author's abstract)
W89-04941

FAST-NEUTRON-ACTIVATION ANALYSES OF VARIOUS WATER SOURCES OF EAST CENTRAL INDIANA,
Ball State Univ., Muncie, IN. Dept. of Physics and Astronomy.
For primary bibliographic entry see Field 5A.
W89-05006

ALUMINIUM AND FLUORIDE IN THE WATER SUPPLY AND THEIR REMOVAL FOR HEAMODIALYSIS,
Royal Hallamshire Hospital, Sheffield (England). Dept. of Medical Physics and Clinical Engineering.
A. P. Cameron, P. J. Drury, G. A. Harston, and P. R. Ineson.
Science of the Total Environment STENDL, Vol. 76, No. 1, p 19-28, September 15 1988. 5 fig, 3 tab, 26 ref.

Descriptors: *Water treatment, *Water supply, *Aluminum, *Fluoride, *Dialysis, United Kingdom, Hemodialysis.

Aluminum and fluoride in the water supply and their removal for hemodialysis have been investigated in the Trent Region, United Kingdom, and wide variations noted. The efficiency of removal of these elements from the main water supplying home hemodialysis units by different water treatment systems currently installed has been assessed and a follow-up study performed 8 months later. Some improvement in water treatment was noted, with the percentage of home dialysis units receiving waters within the proposed European Economic Community guidelines for aluminum rising from 61.7 to 72.1%. Removal of fluoride by the different treatment mechanisms is analogous to that for aluminum. A comparison of new and older water treatment systems has shown that there is a deterioration in performance with use. However, some cases of poor removal may be due to the installation of unsuitable equipment or, more probably, to a change in the waters used to supply the different homes. Thus, adequate maintenance of equipment and frequent sampling of both untreated and treated waters are required in order to maintain the provision of waters suitable for the preparation of dialysate. (Author's abstract)
W89-05008

COLIPHAGES AND ENTERIC VIRUSES IN THE PARTICULATE PHASE OF RIVER WATER,
Institut Armand-Frappier, Laval (Quebec). Centre de Recherche en Virologie.
For primary bibliographic entry see Field 5B.
W89-05021

CHLORINATED DRINKING WATER IS MUTAGENIC AND CAUSES 3-METHYLCHOLANTHRENE TYPE INDUCTION OF HEPATIC MONOOXYGENASE,
National Public Health Inst., Kuopio (Finland). Dept. of Environmental Hygiene and Toxicology.
A. Liimatainen, D. Muller, T. Vartiainen, F. Jahn, and U. Kleeberg.
Toxicology TXCYAC, Vol. 51, No. 2/3, p 281-289, October 1988. 2 fig, 2 tab, 32 ref.

Descriptors: *Drinking water, *Chlorination, *Finland, *Wastewater treatment, *Toxicity, *Mutagenicity, Enzymes, Liver, Ames test, Bacteria, Rats, Cytochrome P-450.

Acid/neutral fractions of four chlorinated drinking water samples were tested for mutagenicity in the Ames' test and injected intraperitoneally to 10- and 20-day-old Wistar rats at doses of 200 and 100 liters of water/kg body weight. Cytochrome P-450 mediated enzyme activities of ethylmorphine-N-demethylase (EMND), 7-ethoxycoumarin-O-deethylase (ECOD), 7-ethoxyresorufin-O-deethylase (EROD) and 7-pentoxyresorufin-O-dealkylase (PEROD) were determined in the 9000 g supernatant fraction of liver homogenate. EROD was induced by the concentrates. The induction was related to the mutagenic activity. About 4-fold increase in activity was observed with the most mutagenic sample. PEROD was also slightly enhanced. EMND and ECOD activities were not affected by the lower dose, but the higher dose caused inhibition of 30-40%. Although the extracts were not toxic to bacteria, they were unexpectedly toxic to rats. It is concluded that the samples contained 3-methylcholanthrene type inducer(s). (Author's abstract)
W89-05052

ESTIMATING RESIDENTIAL PRICE ELASTICITY OF DEMAND FOR WATER: A CONTINGENT VALUATION APPROACH,
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
For primary bibliographic entry see Field 6D.
W89-05055

TREATMENT OF WATER FOR AQUATIC BACTERIAL GROWTH STUDIES,
Thames Water Authority, London (England).
J. S. Colbourne, R. M. Trew, and P. J. Dennis.
Journal of Applied Bacteriology JABAA4, Vol. 65, No. 1, p 79-85, July 1988. 5 tab, 31 ref.

Descriptors: *Aquatic bacteria, *Growth media, *Water treatment, *Microbiological studies, Sample preparation, Sterilization, Chemical properties, Chemical analysis, Membrane filters.

The composition of a water is inextricably linked to its nutrient status and hence influences the behavior of bacteria in artificial water systems. It has not yet been possible to devise a defined liquid medium representative of the complex composition of a treated water. Instead sterilized natural or distilled waters are used to study the growth or survival of aquatic bacteria in the laboratory. This has led to conflicting data and opposing opinions when the same water has proved toxic in some laboratory studies and growth-supporting in others. These differences may be explained by the variations in chemical composition which occur when water is collected, transported and treated or stored in the laboratory. This study describes a simple, membrane filtration method of preparing a fresh sample of water collected from the environment or a building water system such that it is both sterile and chemically unaltered. The method is based on the large volume positive pressure membrane filtration technique using a peristaltic pump developed for the isolation of legionellas from water. The availability of this method may enhance understanding of the behavior of bacteria in the aquatic environment. (Author's abstract)
W89-05219

GRAVEL PACKED BAFFLED CHANNEL FLOCCULATOR,
American Univ., Beirut (Lebanon). Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W89-05233

METHOD FOR OPTIMAL DESIGN OF BRANCHED NETWORKS ON FLAT TERRAIN,
Asian Inst. of Tech., Bangkok (Thailand). Div. of Industrial Engineering and Management.
O. Fujiwara, and D. Dey.
Journal of Environmental Engineering JOEDDU, Vol. 114, No. 6, p 1464-1475, December 1988. 5 tab, 1 fig, 21 ref.

Descriptors: *Network design, *Water distribution, *Pipelines, *Water mains, *Hydraulic geometry, Branched networks, Conveyance structures, Flat terrain, Computers, Optimization.

A computationally efficient two-stage method for the optimal design of branched water distribution networks on flat terrain is proposed. In the initial stage, the Lagrange multiplier method is used to obtain continuous optimal pipe sizes and Lagrange multipliers analytically. It is not necessary here to solve a system of linear equations and only simple arithmetic operations are needed. For any method in which continuous diameters are evaluated, a heuristic procedure is used to round off the continuous diameter into discrete diameters. The present method, however, uses the analytical solution obtained in the first stage to select a restricted candidate list of commercially available pipe sizes for input to an linear programming (LP) model. When the proposed method is applied to branched networks of different sizes and complexities, it is observed to be computationally more efficient than the LP model. Moreover, the optimal solution obtained by the proposed method coincides with

the optimal solution obtained by the LP model for all branched networks so far randomly generated. (Author's abstract)
W89-05234

PREDICTING INTERNAL ROUGHNESS IN WATER MAINS,
Waterways Experiment Station, Vicksburg, MS.
For primary bibliographic entry see Field 8G.
W89-05245

TRACE METAL CONTAMINATION FROM BRASS FITTINGS,
Illinois State Water Survey Div., Champaign. Aquatic Chemistry Section.
M. R. Schock, and C. H. Neff.
Journal of the American Water Works Association JAWWA5, Vol. 80, No. 11, p 47-56, November 1988. 17 fig, 2 tab, 27 ref. Grant CR80855602.

Descriptors: *Trace metals, *Heavy metals, *Brass, *Water pollution sources, *Plumbing, *Drinking water, Contamination, Lead, Copper, Zinc, Corrosion, Standing waters.

Data were obtained during a two-year field and laboratory corrosion study that implicated brass valves and fittings as a potential source of lead, copper, and zinc in drinking water, particularly in standing water. Contamination from this source was found to be a significant cause of metal concentrations that exceeded maximum contaminant levels. These findings should be considered in the design of water sampling programs, the selection of plumbing materials for household use, and the planning of corrosion-rate measurement and plumbing material solubility experiments. (Author's abstract)
W89-05247

ROLE OF BICARBONATE IN BACTERIAL GROWTH IN OLIGOTROPHIC WATERS,
Brussels Water Board (Belgium).
G. Fransolet, A. Depelchin, G. Villers, R. Goossens, and W. J. Masschelein.
Journal of the American Water Works Association JAWWA5, Vol. 80, No. 11, p 57-61, November 1988. 9 fig, 32 ref.

Descriptors: *Drinking water, *Water conveyance, *Bicarbonates, *Bacteria, *Water quality, Oligotrophy, Growth rates, Organic carbon, Potassium, Limiting nutrients, Population dynamics.

Six strains of bacteria among those identified to occur repeatedly among bacteria isolated from aftergrowth in public water distribution systems included Pseudomonas, Azomonas, Escherichia coli, Aeromonas, and Enterobacter strains. The growth-rate constant of these six strains of bacteria in oligotrophic waters was found to be highly dependent on the bicarbonate content of the water. This phenomenon explains the problem of bacterial aftergrowth that sometimes occurs in water distribution systems - even when assimilable organic carbon is scarce. The level of organic carbon, however, appears to affect the growth yield. Potassium was observed to be a limiting factor of bacterial growth. (VerNooy-PTT)
W89-05248

PREDICTING PIPELINE FROST LOAD,
Ontario Ministry of the Environment, Toronto.
For primary bibliographic entry see Field 2C.
W89-05249

SELECTED DRINKING WATER CHARACTERISTICS AND ATTACHED MICROBIAL POPULATION DENSITY,
Philadelphia Suburban Water Co., Bryn Mawr, PA.
R. M. Donlan, and W. O. Pipes.
Journal of the American Water Works Association JAWWA5, Vol. 80, No. 11, p 70-76, November 1988. 5 fig, 8 tab, 17 ref.

Descriptors: *Water quality, *Drinking water, *Microorganisms, *Water properties, *Water treatment facilities, Aquatic populations, Population density, Statistical analysis, Water mains.

Cast-iron test surfaces in a distribution system were exposed to ascertain the relationship between suspended microbial population density, chloramine residual, velocity, water temperature, and selected average solute concentrations and attached microbial population density. The population of attached microorganisms was directly related to water temperature and suspended microbial population density and indirectly related to chloramine concentration and maximum velocity using either analysis of variance or linear correlation. Statistical analysis using linear correlation could demonstrate no strong relationships between pH, alkalinity, organic nitrogen, ammonia, nitrite, nitrate, total phosphate, orthophosphate, or total organic carbon and attached microbial population density. (Author's abstract)
W89-05250

DEGRADATION OF 2-METHYLISOBORNEOL BY AQUATIC BACTERIA,
Southern California Metropolitan Water District, La Verne. Water Quality Branch.
G. Izaguirre, R. L. Wolfe, and E. G. Means.
Applied and Environmental Microbiology AEMIDF, Vol. 54, No. 10, p 2424-2431, October 1988. 3 fig, 3 tab, 41 ref.

Descriptors: *Water treatment, *Biodegradation, *Degradation, *Biochemistry, *Microbial degradation, *Path of pollutants, Chemical reactions, Chemical properties, Water treatment, Culturing techniques.

2-Methylisoborneol (MIB) is a musty-smelling or muddy-smelling compound that occurs in some natural waters and that is difficult to remove by conventional water treatment methods. Bacterial degradation of MIB was examined in batch culture experiments. Cultures able to metabolize MIB were enriched in a mineral salts medium supplemented with milligram/L levels of the compound and were inoculated with water and sediment samples from reservoirs where MIB is seasonally produced. Bacteria from degrading cultures were isolated on R2A agar and identified as predominantly Pseudomonas spp. Degradation occurred only in cultures consisting of three or more different bacteria. MIB supported growth as the sole added carbon source at 1 to 6.7 mg/L. MIB was also degraded at microgram-per-liter levels in sterile filtered lake water inoculated with washed bacteria and in synthetic medium supplemented with various sugars or acetate. Complete degradation of MIB took from 5 days to more than 2 weeks. Enrichment with isoborneol, a structural analog of MIB, failed as a preenrichment for MIB degraders. Isoborneol at 20 to 40 mg/L readily supported bacterial growth, whereas MIB at 12 to 20 mg/L took months to degrade. The relative recalcitrance of MIB compared with isoborneol may be a result of the additional methyl group in MIB. (Author's abstract)
W89-05302

INACTIVATION OF GIARDIA LAMBLIA AND GIARDIA CANIS CYSTS BY COMBINED AND FREE CHLORINE,
Auburn Univ., AL. Coll. of Veterinary Medicine.
L. I. Kong, L. J. Swango, B. L. Blagburn, C. M. Hendrix, and E. E. Williams.
Applied and Environmental Microbiology AEMIDF, Vol. 54, No. 10, p 2580-2582, October 1988. 2 tab, 18 ref. Air Force Engineering And Service Center Contract DAMD-17-82-C-2257.

Descriptors: *Water treatment, *Pathogens, *Protozoa, *Chlorination, *Potable water, *Giardia, *Drinking water, *Water pollution control, Disinfection, Bactericides, Microorganisms, Chlorine, Organic compounds, Public health, Comparison studies, Water pollution.

The presence of Giardia lamblia in potable water supplies is a serious problem throughout the world in that it causes a severe form of dysentery. In light of recent laboratory work showing that certain organic N-halamine compounds are very stable, persistent disinfectants in water for a variety of organisms, free chlorine and a combined organic N-chloramine (3-chloro-4,4-dimethyl-2-oxazolidinone, compound 1) were compared for efficacy as disinfectants against an admixture of cysts of Giardia lamblia and Giardia canis in water solution under a variety of test conditions; variables were pH, temperature, and water quality. In general, compound 1 was found to reduce the giardial excystation in the solutions at lower concentration or shorter contact time at a given chlorine concentration than did free chlorine. (Author's abstract)
W89-05307

IS FREE HALOGEN NECESSARY FOR DISINFECTION,
Auburn Univ., AL. Dept. of Chemistry.
D. E. Williams, E. D. Elder, and S. D. Worley.
Applied and Environmental Microbiology AEMIDF, Vol. 54, No. 10, p 2583-2585, October 1988. 2 tab, 14 ref. Air Force Engineering and Services Center Contract DAMD17-82-C-2257.

Descriptors: *Water treatment, *Anions, *Chlorination, Halogens, *Disinfection, *Organic compounds, *Staphylococcus, *Bactericides, Bacteria, Bromine, Chlorine, Comparison studies, Water pollution control, Chemical reactions, Hydrolysis.

The principle of Le Chatelier was used in demonstrating that 3-chloro-4,4-dimethyl-2-oxazolidinone (compound 1) itself kills Staphylococcus aureus rather than the very small amount of free chlorine in hydrolysis equilibrium with compound 1. On the other hand, when the N-bromo analog of compound 1 (compound 1B) was used as the disinfectant, the mixture of combined compound 1B and free bromine formed in the hydrolysis equilibrium provided disinfection. When the hydrolysis equilibrium for 1B was suppressed to the level at which a negligible amount of free bromine remained in solution, combined compound 1B was much more efficacious than combined compound 1 at killing S. aureus. (Author's abstract)
W89-05308

DRINKING WATER SOURCE, DIARRHEAL MORBIDITY, AND CHILD GROWTH IN VILLAGES WITH BOTH TRADITIONAL AND IMPROVED WATER SUPPLIES IN RURAL LESOTHO, SOUTHERN AFRICA,
Johns Hopkins Univ., Baltimore, MD. Dept. of International Health.
For primary bibliographic entry see Field 5C.
W89-05320

VALUE OF WATER SUPPLY AND SANITATION IN DEVELOPMENT: AN ASSESSMENT,
North Carolina Univ. at Chapel Hill. Dept. of Environmental Sciences and Engineering.
D. A. Okun.
American Journal of Public Health AJHEAA, Vol. 78, No. 11, p 1463-1467, November 1988. 27 ref.

Descriptors: *Water treatment, *Developing countries, *Economic aspects, *Water supply, *Water quality, *Water quality control, *Public health, *Human diseases, Water use, Human populations.

The attractiveness of oral rehydration therapy (ORT), a new and simple ministration that averts many child deaths from diarrhea among children, is diverting attention among donor agencies from the importance of water supply and sanitation (WS and S) in developing nations. The principal factor that led to the adoption of ORT is its apparent low cost per diarrheal death averted in children when compared with WS and S. However, WS and S provides many more benefits that are essential to sustaining the lives saved by ORT and vital to maintaining and enhancing the lives of adults and children. Among many other benefits, WS and S prevents spread of the causes of diarrhea, controls many other water- and sanitation-related diseases, releases women from the heavy and time-consuming burden of carrying water from distant sources, and improves the quality of life in the community. Cost comparisons between WS and S and ORT are

misleading. WS and S is a long-term investment in preventive health while ORT is a response to an immediate life-threatening situation. WS and S interventions eliminate unsanitary conditions leading to illness and death while ORT has no effect on the causes of diarrheal morbidity. The costs of WS and S are not high: $5 to $10 per capita annually. Without WS and S and hygiene education, ORT programs are not likely to effect long-term improvement in child health status. ORT and WS and S programs are complementary; one should not displace the other. (Author's abstract)
W89-05321

FORMATION OF AMES MUTAGENICITY AND OF THE STRONG BACTERIAL MUTAGEN 3-CHLOR-4-(DICHLOROMETHYL)-5-HYDROXY-2(5H)-FURANONE AND OTHER HALOGENATED COMPOUNDS DURING DISINFECTION OF HUMIC WATER,
Abo Akademi, Turku (Finland). Dept. of Organic Chemistry.
P. Backlund, L. Kronberg, and L. Tikkanen.
Chemosphere CMSHAF, Vol. 17, No. 7, p 1329-1336, 1988. 2 tab, 29 ref.

Descriptors: *Water pollution sources, *Water chemistry, *Ames test, *Chlorinated hydrocarbons, *Chemical reactions, *Disinfection, *Humic acids, *Mutagenic effects, Organic compounds, Water treatment, Chemical properties.

Humic water was treated with different disinfectants and examined for mutagenicity, 3-chloro-4-(dichloromethyl)-5-hydroxy-2(5H)-furanone (MX), E-2-chloro-3-(dichloromethyl)-4-oxobutenoic acid (E-MX), adsorbable halogenated organics (AOX), and chloroform. The highest mutagenic activity and the highest concentrations of MX and E-MX were noted for water disinfected with chlorine. An increased proportion of chlorine dioxide in the combined chlorine/chlorine dioxide treatment resulted in a decrease in the mutagenic activity and in the concentrations of MX, E-MX, AOX and chloroform. Ozone treatment prior to chlorination gave a slight decrease in mutagenicity and in the concentrations of MX and E-MX. Although the amount of AOX in monochloramine-treated water was comparable to that in chlorinated water, chloramination produced considerably lower mutagenicity and lower concentrations of MX and E-MX. MX was responsible for 20-50% and E-MX for a few percent of the mutagenic activity generated by the disinfectants. (Author's abstract)
W89-05331

AMES MUTAGENICITY AND CONCENTRATION OF THE STRONG MUTAGEN 3-CHLORO-4-(DICHLOROMETHYL)-5-HYDROXY-2(5H)-FURANONE AND OF ITS GEOMETRIC ISOMER E-2-CHLORO-3-(DICHLOROMETHYL)-4-OXO-BUTENOIC ACID IN CHLORINE-TREATED TAP WATERS,
Abo Akademi, Turku (Finland). Dept. of Organic Chemistry.
For primary bibliographic entry see Field 5C.
W89-05367

TRAINING SUPPORT FOR URBAN SANITATION ACTIVITIES IN DJIBOUTI,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
For primary bibliographic entry see Field 5D.
W89-05369

TRAINING OF TRAINERS WORKSHOP III AND TRAINING MATERIALS DEVELOPMENT FOR THE WATER AND SANITATION COMPONENT OF SANRU II,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
H. L. Jennings, and A. Prins.
Water and Sanitation for Health Project Field Report No. 216, November 1987. 73p, 1 fig, 6 append. AID Project Contract 5942-C-00-4085-00, Project 936-5942.

Descriptors: *Water supply development, *Rural areas, *Sanitation, *Training, *Zaire, *Developing countries, *Education, *Planning, Water supply, Public health.

The Water and Sanitation for Health (WASH) Project assisted the USAID Mission in Zaire under Activity No. 355 to further develop a national training capability for the Government of the Republic of Zaire's (GOZ) rural water supply and sanitation (RWSS) sector. Two consultants designed and implemented a two-week advanced training-of-trainers (TOT) workshop for members of the National Training Team for Water and Sanitation (ENFEA). In 1985, USAID/Zaire requested WASH assistance in developing an overall strategy and training plan for the water and sanitation component of the SANRU II Project. The purpose of the SANRU II Project is to establish sustainable community-supported primary health care systems in 50 rural health zones in Zaire. The water and sanitation component of the SANRU II Project includes two separate but interrelated elements. The first supports SANRU II-assisted rural health zones staff to improve their ability to plan and carry out water and sanitation activities. The second helps to strengthen the National Rural Water Service (SNHR), which is responsible for constructing rural water systems throughout Zaire. The project, therefore, has training needs within both the rural health zones and the rural water brigades of SNHR. This assignment involved three phases: an initial one-week needs assessment and TOT design period, the two-week advanced TOT workshop, and a final week for documenting the process and providing additional guidance on materials preparation and future planning. (Lantz-PTT)
W89-05370

TRAINING OF TRAINERS IN OPERATIONS AND MAINTENANCE FOR RURAL POTABLE WATER SYSTEMS IN BOLIVIA,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
D. B. Edwards.
Water and Sanitation for Health Project Field Report No. 202, January 1987. 50p, 1 tab, 3 append. AID Contract 5942-C-00-4085-00, Project 936-5942.

Descriptors: *Potable water, *Water supply development, *Education, *Developing countries, *Bolivia, *Training, Rural areas, Maintenance, Water supply.

At the request of USAID/Bolivia, Water and Sanitation for Health (WASH) Project consultants conducted a two-week training-of-trainers' workshop in operations and maintenance (O and M) in Cochabamba, Bolivia. This workshop was the third installment in a four-part technical assistance package provided by WASH consultants to the Department of Environmental Sanitation (DSA) of the Ministry of Social Services and Public Health. In addition to the acquisition of skills and knowledge relating to training, the workshop produced a trainer's manual and a plan for using it to train community operators in how to operate and maintain their systems. If the results of this course and the series of courses which have been conducted by WASH are to have any long-lasting effects, DSA and USAID/Bolivia must be prepared to carry out and support the development of plans and programs for the transition from construction of systems to operating and maintaining them. These WASH courses represent only a beginning in what will need to be a much larger effort. Suggestions for the future include: A refresher course within six months; The development of a long-range O and M plan for DSA; and Use of the O and M training manuals developed by WASH to carry forward more O and M training by the DSA staff who have been trained by WASH as instructors. (Lantz-PTT)
W89-05371

GUIDELINES FOR DESIGNING A HYGIENE EDUCATION PROGRAM IN WATER SUPPLY AND SANITATION FOR REGIONAL/DISTRICT LEVEL PERSONNEL,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
For primary bibliographic entry see Field 5D.
W89-05372

SMALL RURAL WATER SYSTEMS PROJECT IN THE YEMEN ARAB REPUBLIC; A MID-TERM EVALUATION,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
D. Laredo, J. W. Dawson, and M. Hashem.
Water and Sanitation for Health Project Field Report No. 197, September 1986. 120p, 6 fig, 3 tab, 7 append. AID Contract 5942-C-00-4085-00, Project 936-5942.

Descriptors: *Developing countries, *Institutional constraints, *Yemen, *Rural areas, *Water supply development, Evaluation, Public policy, Rural sociology, Water supply, Management planning.

A midterm evaluation for USAID/Yemen of Phase II of the Small Rural Water Systems Project was conducted from September 8 to 30, 1986. This second phase was intended to provide institutional development services to strengthen the managerial, technical, and financial capabilities of the Rural Water Supply Department (RWSD) of the Ministry of Public Works (MPW) so that the department could effectively respond to the need for improved village water systems. Findings includes: (1) The project's field accomplishments may be classified as an unqualified success. The contractor, New Trans Century Foundation (NTF), has overcome the combined constraints of logistics and terrain to produce 172 water supply systems that are well engineered and constructed according to high-quality standards; (2) In reaching this level of field expertise, NTF has organized itself into a highly efficient turnkey construction unit, and its staff have mastered the intricacies and political sensitivities of many elements of Yemen's rural society; and (3) The primary objective of Phase II, however, as stated in the Grant Agreement, was to provide institutional development (ID) services to RWSD. In this realm, the project is far from successful, as NTF has made little headway on its ID objectives vis a vis RWSD. This observation is not meant to imply RWSD was a willing partner in the process. RWSD operates as a pure development agency envisioning its mission almost exclusively as an agency to provide rural water supply infrastructure. This fact, together with a set of unclear institutional objectives in the Memorandum of Understanding between AID and RWSD, exacerbated the situation. Further, the fact that RWSD did not, as expected at the time of NTF's proposal, become an autonomous agency certainly did not improve the project's institutional development environment. (Lantz-PTT)
W89-05373

COMMUNITY PARTICIPATION IN WATER SUPPLY PROJECTS AS A STIMULUS TO PRIMARY HEALTH CARE: LESSONS LEARNED FROM AID-SUPPORTED AND OTHER PROJECTS IN INDONESIA AND TOGO,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
E. Eng, J. Briscoe, A. Cunningham, K. Kilapong, and J. Naimoli.
Water and Sanitation for Health Project Technical Report No. 44, May 1987. 56p, 6 fig, 21 ref, 3 append. AID Contract 5942-C-00-4085-00, Project 936-5942.

Descriptors: *Public participation, *Water supply development, *Public health, *Indonesia, *Togo, Mortality, *Developing countries, Rural areas, Public policy.

Research was conducted on the influence of community participation in water supply projects on the subsequent participation of community members in other primary health care and child survival activities. Field research focused on four projects (AID-supported and other) in Indonesia and Togo, but the findings are important for all primary health care, child survival, and water supply policy-making and programming. Participatory water supply projects (water supply projects that emphasize community involvement) appear to

have a 'stimulus effect' on a community's subsequent involvement in primary health care activities. Participation in immunization and perhaps other primary health care and child survival activities is greater in communities in which participatory water supply projects have been carried out than in communities where no water supply project has been carried out. Given the need to increase the participation of rural people in primary health care and child survival activities, a community participation strategy should be developed to link water projects with other health activities being introduced in rural communities. This strategy needs to be long-range and sequenced. (Lantz-PTT)
W89-05374

BENIN RURAL WATER SUPPLY AND SANITATION PROJECT START-UP WORKSHOP, APRIL 7-10, 1987,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
H. L. Jennings.
Water and Sanitation for Health Project Field Report No. 207, April 1987. 117p, 9 append. AID Contract 5942-C-00-4085-00, Project 936-5942.

Descriptors: *Management planning, *Workshops, *Benin, *Water supply development, *Sanitation, *Developing countries, Developing countries.

A request for technical assistance for the design and implementation of a preimplementation workshop for the Benin Rural Water Supply and Sanitation Project was issued in January 1987 by the USAID Mission in Lome to the Water and Sanitation for Health (WASH) Project. This report describes the background, planning, implementation, and results of the workshop. The purpose of the Benin Rural Water Supply and Sanitation Project is to improve the health and living conditions in central Benin by providing water supply and sanitation services in 250 villages. The workshop was designed as a team-building event. The majority of the workshop time was spent working in groups on project issues: how to work together; how to manage the project; clarification of roles, responsibilities, and authority; how to minimize or resolve key issues (problem areas); and planning of key activities through the end of 1987. Activities were task-oriented, designed to produce tangible results, and highly participatory. It is recommended that a similar workshop be held at least once a year and last four full days; that an in-house review of project management and team relations should take place at least every 6 mos; and that a similar workshop be held within the next 3-4 mos involving all members of the provincial and district teams. (Lantz-PTT)
W89-05375

MID-TERM EVALUATION OF THE CARE WATER SUPPLY AND SANITATION PROJECT IN BELIZE,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
J. E. Turner, and S. Buzzard.
Water and Sanitation for Health Project Field Report No. 206, May 1987. 65p, 5 tab, 3 append. AID Contract 5942-C-00-4085-00, Project 936-5942.

Descriptors: *Water supply development, *Sanitation, *Belize, Water supply, Developing countries, Water conveyance, Wells, Drilling, Public health, Education.

This report constitutes the mid-term evaluation of the USAID- and CARE-funded Village-Level Water and Sanitation (VLWS) Project in Belize. The VLWS Project is designed to provide water supply and sanitation (latrines) to 16 villages in the Orange Walk and Corozal districts. The project will install approximately 100 new wells with India Mark II handpumps and two rudimentary water systems (RWS)--distribution systems that use either electrical or diesel-driven pumps. The project will also install up to 1,600 latrines and is intended to serve an estimated 8,500 beneficiaries. To evaluate project performance, the WASH evaluation team visited 9 of 16 communities in the VLWS Project and also interviewed USAID, CARE, and Government of Belize personnel. On the basis of the observations made and information gathered, the WASH team believes that the VLWS project has developed a good health education program for both adults and school children. Project personnel are using the system of health education modules to work closely with the communities to increase the impact of the water supply and sanitation infrastructure. Recommendations included: (1) increase staff from both CARE and the Ministry of Natural Resources (MNR) to speed up implementation of the project; and (2) to increase well-drilling effectiveness, USAID should provide a long-term (1-1/2 to 2 years) advisor to train MNR drilling crews. If possible, new light-weight drilling equipment should be provided to replace the aging existing equipment. (Lantz-PTT)
W89-05376

REPORT ON TECHNICAL ASSISTANCE TO THE VILLAGE-LEVEL WATER AND SANITATION PROJECT, CARE/BELIZE,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
For primary bibliographic entry see Field 5D.
W89-05378

MALAWI SELF-HELP RURAL WATER SUPPLY PROGRAM: FINAL EVALUATION,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
D. B. Warner, J. Briscoe, C. Hafner, and B. Zellmer.
Water and Sanitation for Health Project Field Report No. 186, August 1986. 143p, 14 fig, 22 tab, 39 ref, 5 append. AID Contract 5942-C-00-4085-00, Project 936-5942.

Descriptors: *Malawi, *Rural areas, *Water supply development, *Developing countries, Evaluation, Public participation, Water supply, Sanitation, Water conveyance, Economic aspects.

This report constitutes the final evaluation of the USAID-financed Malawi Self-Help Rural Water Supply Program. The evaluation was performed by a four-person team sent from the Water and Sanitation for Health (WASH) Project in Washington, DC., from 4 to 24 May 1986. As in the mid-term evaluation, the evaluation team finds that the strengths of the project lie in the full involvement of the user communities, field staff within the Ministry of Works and Supplies (MOWS) and Ministry of Health (MOH), which are sensitive to the needs of a community-based approach to rural water and sanitation development, and dedicated senior staff within the MOWS and MOH. Recommendations for the USAID-Financed Project include: (1) Strengthen the Health Education and Sanitation Program (HESP) component in the MOH by adding another senior health officer and providing more money for field activities; (2) Incorporate washing slabs into the rural piped water construction program of the MOWS; (3) Carry out a study of the remaining potential for rural piped water projects; (4) Prepare a manpower needs assessment for the rural piped water program in the MOWS and MOH; and (5) Form a small working group to oversee details of management of remaining project funds. (Lantz-PTT)
W89-05379

WATER SUPPLY TECHNICAL ASSISTANCE COLONIA FELIPE ANGELES, CIUDAD JUAREZ, CHIHUAHUA, MEXICO,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
For primary bibliographic entry see Field 2F.
W89-05380

MIDTERM EVALUATION OF THE USAID/CARE COMMUNITY WATER SYSTEMS DEVELOPMENT PROJECT IN THE REPUBLIC OF HAITI,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
For primary bibliographic entry see Field 5D.
W89-05381

FINAL EVALUATION OF USAID/CATHOLIC RELIEF SERVICES WATER AND SANITATION PROGRAM IN ECUADOR, PERU, GUATEMALA, HONDURAS AND THE DOMINICAN REPUBLIC,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
O. R. Larrea, R. M. Schneider, R. Duncan, and H. Silva.
Water and Sanitation for Health Project Field Report No. 201, January 1988. 358p, 1 tab, 5 append. AID Contract 5942-C-00-4085-00, Project 936-5942.

Descriptors: *Water supply development, *Sanitation, *Ecuador, *Peru, *Guatemala, *Honduras, *Dominican Republic, *Developing countries, *Training, Economic aspects, Rural areas, Public health, Personnel, Education, Evaluation.

This report presents a final evaluation of a joint USAID/Catholic Relief Services (CRS) Water and Sanitation Program implemented in five Latin American countries: Ecuador, Peru, Guatemala, Honduras, and the Dominican Republic. The program was funded by a matching grant agreement between CRS-New York and AID's Office of Private and Voluntary Cooperation (PVC) for a total of $2,475,000 during the project period from 1 January 1984 to 31 December 1986. Based on meetings in the countries with USAID and CRS officials and project site visits in each country, the teams drew numerous conclusions and presented recommendations. The following summarizes some of the major points of the overall CRS program in the five countries: (1) The evaluation teams found the CRS program to be well targeted to communities that are in need and unlikely to obtain other sources of assistance; (2) The evaluation teams recommends that USAID continue to fund similar programs with CRS for the construction of water supply and sanitation projects; (3) System design, technology and level of service are generally adequate to provide sufficient amounts of water. The team recommends that CRS continue to use the simple, low-cost construction standards generally used by a country's water authority; (4) Water and sanitation education activities were promoted at the community level, coordinated with construction activities. CRS should make more of an investment in time and money to develop curricula and training materials for health education activities. CRS water supply and sanitation project management staff have varied experience and were often available only on a limited basis. CRS should attempt to standardize the criteria for selection of water supply and sanitation project management personnel to provide consistent project supervision. Selected personnel should be trained in critical areas and there should be an effort to bring together CRS project staff and project holders for courses and conferences to share experiences and efforts. (Lantz-PTT)
W89-05382

PRIVATIZATION STUDY OF THE VILLAGE WATER SUPPLY AND SANITATION (VWSS) PROJECT LESOTHO,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
P. Roark, J. S. Baker, S. Buzzard, and H. A. Cauley.
Water and Sanitation for Health Project Field Report No. 215, September 1987. 113p, 8 fig, 13 tab, 36 ref, 4 append. AID Contract 5942-C-00-4085-00, Project 936-5942.

Descriptors: *Water supply development, *Management planning, *Sanitation, *Lesotho, *Economic aspects, *Rural areas, Developing countries, Policy making, Water supply, Costs, Maintenance.

USAID's involvement in Lesotho's Rural Water and Sanitation Project is drawing to a close. The project has more than exceeded expectations concerning the installation of new systems and the Government of Lesotho (GOL) will be left with hundreds of additional systems to maintain at the conclusion of U.S. funding in September 1988. Concern has been expressed over the GOL's ability to continue to fund maintenance of these and

pre-existing systems at the level required to assure sustained and reliable water services to rural communities. This concern has led USAID to explore options concerning how best to assure continued serviceability of the rural systems. The approach explored in this study involves the transfer of maintenance responsibilities from the public sector to private entities. After establishing the context within which privatization activities would be undertaken, several scenarios were designed and evaluated and a specific program is recommended. The key findings of the study are: (1) Privatization has not been dealt with to any significant degree at the policy-making level by GOL agencies; (2) Earlier water projects in the rural communities encountered difficulties in sustainability due to a lack of emphasis on community responsibilities for maintenance. There are indications that communities may still be reluctant to assume maintenance responsibilities and that local capabilities for implementing cost recovery would need to be significantly upgraded to overcome these attitudes; (3) The technical features of the rural water supply program appear sound and appropriate to the conditions; (4) An assessment of private-sector capabilities indicates that there is an existing cadre of firms willing and able to participate in the maintenance of rural water-supply systems; and (5) The recommendations include near-term initiation of privatization of handpump maintenance in the four lowlands districts if competitive bids confirm the prospective benefits in terms of long-term cost savings and service improvements. (Lantz-PTT)
W89-05383

WILLINGNESS TO PAY FOR WATER IN RURAL AREAS: METHODOLOGICAL APPROACHES AND AN APPLICATION IN HAITI,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
D. Whittington, J. Briscoe, X. Mu, W. Barron, and J. M. Duval.
Water and Sanitation for Health Project Field Report No. 213, September 1987. 93p, 2 fig, 11 tab, 4 photos, 72 ref, 2 append. AID Contract 5942-C-00-4085-00, Project 936-5942.

Descriptors: *Payment, *Rural areas, *Haiti, *Developing countries, Public participation, Economic aspects, Water supply development, Water costs.

The planning experiences of the U.S. Agency for International Development (USAID), the World Bank, and the Inter-American Development Bank (IDB) in the rural water sector are reviewed in order to: (1) identify cases where willingness-to-pay procedures have been incorporated into the design of rural water projects, and (2) examine rural water supply project evaluations for insights into the factors that determine willingness to pay. On the basis of this review, it was found that the IDB is the only major donor in the sector systematically incorporating willingness-to-pay considerations in its planning and project design procedures. A theoretical model was developed for understanding village water use behavior which attempts to explain both the household's decision regarding which water source to use and how much water to use from that source. Two complementary types of data can be used to estimate such a model describing household water use behavior: The first (or 'direct') approach is simply to interview an individual and ask directly how much he or she would be willing to pay for a public tap or private connection. The second (or 'indirect') approach is to collect data on actual observed behavior. Results of the field test in Haiti suggest that contingent valuation surveys are feasible in developing countries and that an inexpensive, quick survey may provide valuable information on households' willingness to pay for improved water services. Such information could be particularly helpful in: (1) identifying communities which could meet specified cost-recovery targets; (2) determining prices and connection fees to charge for the improved water services; and (3) determining the appropriate level of service and the water system capacity required. (Lantz-PTT)
W89-05384

PREPARATION OF A PLAN OF ACTION FOR THE WATER SUPPLY AND SANITATION COMPONENT OF THE ADB-SPONSORED RURAL HEALTH SERVICES PROJECT IN PAPUA, NEW GUINEA,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
For primary bibliographic entry see Field 5D.
W89-05385

FINAL EVALUATION: USAID/BURKINA FASO RURAL WATER SUPPLY PROJECT,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
P. Roark, B. Kittle, J. Yanogo, D. Nignan, and R. Yonli.
Water and Sanitation for Health Project Field Report No. 191, August 1986. 130p, 5 fig, 16 tab, 53 ref, 2 append. AID Contract 5942-C-00-4085-00, Project 936-5942.

Descriptors: *Burkina Faso, *Rural areas, *Water supply development, *Economic aspects, Public health, Pumps, Wells, Costs, Public participation, Evaluation, Education.

At the request of USAID/Burkina Faso to WASH (Water and Sanitation for Health Project), the final evaluation of the Rural Water Supply Project was undertaken in June and July 1986 by an interdisciplinary team of seven members. The objective of the mission was to focus on project performance, particularly as to water use, and on possible impacts of the project on the target population. The evaluation mission concluded that, in general, the project reached most of its objectives and can, therefore, be considered a success. Specifically, the project constructed 678 wells which have significantly increased the water availability to the population. Because of these successes it was concluded that the project merits a continuation in order to meet water demand for the remaining population of the area. The success ratio of constructing wells with acceptable yields improved with experience as the project progressed. The key element for any rural water supply project is operating and maintaining a pumping system. The project utilized a Moyno pump which has been moderately successful in avoiding breakdowns. Without a doubt, the greatest failure of the project is the lack of a new functioning pump maintenance system. The project has been innovative in its conception by combining a water component with a health education component. Unfortunately, the two components have not proceeded in tandem and the operations of the health component have been truly functional only during the last two years of the project. Unit costs of well construction within the project were rather high. It is recommended that future projects utilize the private sector for drilling wells. (Lantz-PTT)
W89-05387

TRAINING PROGRAM IN VILLAGE WATER SUPPLY PLANNING, MANAGEMENT, DESIGN, CONSTRUCTION, AND MAINTENANCE IN NEPAL: MAY 25 TO JUNE 13, 1986,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
C. R. Johnson.
Water and Sanitation for Health Project Wash Field Report No. 190, August 1986. 75p, 9 fig, 1 tab, 5 append. AID Contract 5942-C-00-4085-00, Project 936-5942.

Descriptors: *Nepal, *Training, *Developing countries, *Water supply development, Education, Potable water, Economic aspects, Water supply, Public participation, Evaluation.

A training program, conducted in Takukot Panchayat (village), Nepal, from May 25 to June 13, 1986, consisted of two training workshops: one in village water supply planning and management and one in village water supply design, construction, and maintenance. The objectives of the training were threefold: (1) to improve the understanding of gravity-flow water supply systems; (2) to increase the technical skills of the overseers, suboverseers, and construction coordinators from Save the Children's Fund (SCF) and other invited organizations, with particular emphasis on the design and maintenance of gravity-flow water supply systems; and (3) To strengthen the training abilities of the overseers, sub-overseers, and construction supervisors from in training village maintenance workers and village maintenance committees in their respective responsibilities and duties for preventive maintenance and repair. The following general recommendations were made to SCF as a result of the training: (1) SCF now has a group of freshly trained administrative and technical staff knowledgeable in village water supply planning, management, design, construction, and maintenance requirements. SCF has a workable step-by-step approach to initiating, implementing, and handing over completed projects to village beneficiaries. Expectations are very high among the field staff and village beneficiaries for successful completion and hand-over of water projects now being finalized. Thus: (1) SCF should take advantage of this time to begin formal hand-over ceremonies and maintenance guidance with the smallest, simplest water projects; (2) the construction of new projects should be linked with the completion of functioning, but as yet incomplete systems on a one-to-one or one-to-two basis; (3) to promote effective source protection measures, SCF should include in its budgeting and estimating for new water supply projects a line item for source protection--the cost of which would be shared by SCF with village contributions; and (4) follow-up training was suggested by several participants. The participants suggested that after one year, the progress made as a result of the training described in this report be evaluated and then additional training be planned. (Lantz-PTT)
W89-05388

REMOVAL OF ORGANICS FROM DRINKING WATER,
Environmental Protection Agency, Cincinnati, OH. Drinking Water Research Div.
B. W. Lykins.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-159058. Price codes: A03 in paper copy, A01 in microfiche. Report No. EPA/600/D-88/008, January 1988. 20p, 8 fig, 7 tab, 19 ref.

Descriptors: *Drinking water, *Water treatment, *Organic compounds, Synthetic organic compounds, Disinfection, Pollutant identification, Groundwater pollution, Volatile organic compounds, Activated carbon, Adsorption, Ozonation, Reverse osmosis.

Organic contamination of drinking water is caused by two general classes of organics; man-made synthetic organics and disinfection of naturally occurring organics (disinfection by-products). Many volatile and non-volatile synthetic organics at trace concentrations are being detected in surface and groundwaters. Contaminated groundwater usually contains two or more predominant organic compounds and several other identifiable ones at lesser concentrations. Surface waters, such as rivers, generally contain many organic compounds in low concentrations. The treatment technologies that EPA's Drinking Water Research Division (DWRD) is evaluating for removal of volatile organic chemicals (VOCs), synthetic organic chemicals (SOCs) and disinfection by-products from water supplies are summarized. Carbon adsorption is effective for removing both VOCs and SOCs. Packed tower and diffused aeration are best suited for removing VOCs. Of the technologies that show promise and are being tested at the bench and pilot scales, conventional treatment with powdered activated carbon (PAC) is effective for removing a few of the SOCs, ozone oxidation is effective for removing certain classes of VOCs and SOCs, and certain reverse osmosis membranes and ultraviolet treatment are also potentially effectively against VOCs and SOCs. (Author's abstract)
W89-05397

LABORATORY EXPERIMENTS ON OIL SPILL PROTECTION OF A WATER INTAKE,
Waterloopkundig Lab. te Delft (Netherlands).
G. A. L. Delvigne.
IN: Oil in Freshwater: Chemistry, Biology, Coun-

termeasure Technology. Pergamon Press, New York, NY, 1987. Edited by John H. Vandermeulen and Steve E. Hrudey. p 446-458, 8 fig, 1 tab, 5 ref.

Descriptors: *Oil spills, *Water pollution prevention, *Oil pollution, *Mathematical models, Numerical analysis, Path of pollutants, Intakes, Oil recovery, Cleanup operations, Emulsions.

The threat of oil pollution to water intakes is a serious problem in areas with oil exploration and production activities, refineries and oil transport. The Delft Hydraulics Laboratory has performed an extensive study of protective measures for the specific case of a cooling water and drinking water intake channel in an area with a high oil-spillage risk. The transport, spread and weathering processes of oil slicks were computed with a numerical simulation model taking into account the local wind and wave conditions and water currents. Protective measures against the penetration of surface-floating oil in the intake channel were tested in a hydraulic scale model in a wind-wave flume with a water depth h = 0.7 m. The tests were aimed at the analysis of the different ways in which floating mechanical barriers and pneumatic barriers may fail to retain the oil. Various types of oil and oil emulsions were used under the (scaled) extreme conditions of wind, waves and currents. The flume experiments led to the following results. Pneumatic barriers fail to retain oil at the entrance of the intake channel because of the entrainment of oil droplets from the oil slick even when the water current velocity in the channel is as low as 0.10 m/sec. Floating barriers fail to retain high-viscous oil and emulsified oil independently of the draft when the normal component of the current exceeds 0.15 m/sec. However, oil can be trapped by a double-boom configuration across the intake channel by taking advantage of the circulation zone behind the first barrier. (See also W89-04530) (Author's abstract)
W89-05461

ADSORPTIVE REMOVAL OF GASOLINE FROM HOUSEHOLD GROUNDWATER SUPPLIES,
Maine Univ. at Orono. Dept. of Civil Engineering.
J. Lowry, T. Potter, and M. Moreau.
IN: Oil in Freshwater: Chemistry, Biology, Countermeasure Technology. Pergamon Press, New York, NY, 1987. Edited by John H. Vandermeulen and Steve E. Hrudey. p 459-473, 9 fig, 6 tab, 7 ref.

Descriptors: *Water treatment, *Groundwater pollution, *Gasoline, *Activated carbon, Water pollution treatment, Adsorption, Separation techniques, Drinking water, Hydrocarbons, Aromatic compounds, Benzenes, Cleanup operations.

The results of research on point-of-use granular activated carbon (GAC) treatment units for removal of gasoline from household groundwater are presented. The study consisted of the isotherm evaluation of nine GAC products, and three pilot-scale GAC adsorption breakthrough experiments covering a 1.0 to 25 m/L contamination range. A primary objective was to collect data to allow a prediction of the bedlife (volume treated) of GAC treatment units. The carbon columns used in the breakthrough studies were operated to simulate a typical pattern of household water use and had eight sampling ports to enable a definition of adsorption profiles over time for specific components. GC and GC/MS analyses indicate that several components breakthrough prior to benzene, toluene, and xylenes, the components most often cited as the compounds of concern in treated water. Thus, other components will possibly control the design life of a GAC bed from either a health or an aesthetic standpoint. Based upon the results of this experiment it was concluded that GAC treatment does not appear to be cost effective in single unit installations where the breakthrough criteria cannot tolerate some small presence of detectable total gasoline in the 100 microgram/L range. GAC treatment is relatively effective if the breakthrough criteria are limited to the presence of benzene, toluene, and/or xylenes. For single household installations a GAC bed capacity in excess of 71 L appears to be required to achieve treated water gasoline concentrations below detection limits for extended periods. The adsorption profile for gasoline creates a need for multi-unit series installations to increase the effective utilization of the GAC. (See also W89-04530) (Geiger-PTT)
W89-05462

SURFACE WATER TREATMENT FOR COMMUNITIES IN DEVELOPING COUNTRIES,
North Carolina Univ. at Chapel Hill. Dept. of Environmental Sciences and Engineering.
C. R. Schulz, and D. A. Okun.
John Wiley and Sons, New York. 1984. 299p.

Descriptors: *Community development, *Water treatment, *Developing countries, *Surface waters, Water treatment facilities, Potable water, Sand filters, Filtration, Chemical treatment, Flocculation.

The design of water supply facilities for communities in developing countries should be based upon the proper application of current technology. The social and economic differences between the developed and the developing world explain why conventional approaches for designing water systems in the industrialized countries are not appropriate in developing countries. The prevailing economies in developing countries, however, are labor-intensive. This implies that a facility which can be built and operated with local labor will likely be more economical and more easily operated than a facility utilizing extensive technology. The following technologies are judged to be of merit in considering options for surface water treatment in communities in developing countries: (1) Pretreatment, which refers to the 'roughing' treatment processes such as plain sedimentation, storage, and roughing filtration, which are designed to remove the larger-sized and settleable material before the water reaches the initial treatment units; (2) Chemicals, including a coagulant, generally alum; disinfectants, generally chlorine or hypochlorites; and, when necessary, alkalies, generally lime, for pH control; (3) Chemical feeders; (4) Hydraulic rapid mixers, rapid mix units are located at the beginning of the plant and are designed to generate intense turbulence in the incoming raw water; (5) Hydraulic flocculators - flocculation follows directly after the rapid mix process and provides gentle and continuous agitation, during which suspended particles in the water coalesce into larger masses so that they may be removed from the water in subsequent treatment processes, particularly by sedimentation; (6) Horizontal-flow settling basins - the sedimentation process is responsible for the settling and removal of suspended material from water; (7) Rapid filters; (8) Slow sand filters; and (9) Modular water treatment plants, which are compact treatment units, preferably made of concrete or masonry in developing countries, and assembled either partly or entirely on-site without large or complicated equipment. (Lantz-PTT)
W89-05506

INFRASTRUCTURE STUDIES: A GUIDEBOOK FOR WATER SUPPLY SYSTEM OPERATORS,
Susquehanna River Basin Commission, Harrisburg, PA.
E. E. Seay, and D. R. Jackson.
Susquehanna River Basin Commission Publication No. 119, September 1988. 48p, 36 ref, append.

Descriptors: *Handbooks, *Operating policies, *Water supply, *Water distribution, *Water treatment, Costs, Policy making, Water management, Public waters, Susquehanna River, Watershed management, Cost analysis, Administrative agencies, Bibliographies.

All infrastructure requires periodic inspection and maintenance. There are about 570 public water supply systems within the Susquehanna River Basin. The vast majority of these have fewer than 1,000 customer connections. State, regional and Federal water resource management agencies are very concerned whether these systems make routine inspections and timely repairs. In order to identify problems within the systems, develop cost-effective programs for repairs or other improvements, and to conserve materials, manpower and natural resources, water supply system operators are urged to undertake infrastructure studies. The primary result of comprehensive studies are long-term cost savings to the system. The quality and cost of an infrastructure study depend directly on the quality and quantity of information available about the system. One purpose of this publication is to identify what information is needed about each component of water supply utility operations (source, transmission, storage, treatment, distribution, and finances) to make the study as accurate and cost-effective as possible. The guidebook includes a preliminary, self-rating survey of water systems, and descriptions of types of infrastructure studies commonly performed together with their data requirements. It offers advice on locating outside assistance and lists agencies concerned with water supply systems. Also included are examples of record keeping forms and a list of articles for further reading about various aspects of system management. (Lantz-PTT)
W89-05510

NEW PARTICIPATORY FRAMEWORKS FOR THE DESIGN AND MANAGEMENT OF SUSTAINABLE WATER SUPPLY AND SANITATION PROJECTS,
United Nations Development Programme, Washington, DC.
P. Donnelly-Roark.
Water and Sanitation for Health Project, Washington, DC. WASH Technical Report No. 52, PROWWESS Report No. 50, November 1987. 30p, 2 tab, 7 ref, append. WASH Contract 5942-C-00-4085-00, Project 936-5942.

Descriptors: *United Nations, *Social aspects, *Management planning, *Public participation, *Water supply development, *Sanitation, Drinking water, Waste disposal, Water management, Water treatment, Wastewater treatment, Water users, Project planning, Social change, Professional personnel, Decision making, Engineering personnel, Public health, Design criteria, Maintenance.

In its approach to water supply and sanitation projects, WASH emphasizes the users and their involvement and ownership of the improved systems in their communities. WASH recognizes women as the most important users of the systems and the critical group for behavior change. PROWWESS seemed a natural project to collaborate with and develop a product useful to both. PROWWESS is an acronym for Promotion of the Role of Women in Water and Environmental Sanitation Services. It is an inter-regional project of the United Nations Development Programme in support of the United Nations International Drinking Water Supply and sanitation Decade (1981-1990). The aim of PROWWESS is to demonstrate ways of achieving women's effective involvement in planning, designing, implementing, operating, and maintaining drinking water and waste disposal schemes and in related health improvement activities. This concept paper is intended for engineers, project officers, and technicians managing water and sanitation projects in the field. It was developed in response to numerous field requests from donor decision-makers and field-level personnel who understand the importance of participation but do not know how to promote it. Project staff should put aside one working day to discuss this paper and to develop a work plan to implement community participation involving women. The work plan should designate staff responsibilities, schedules, and the resources required for implementation. The four primary tasks are: Task 1--Project classification-read the concept paper, noting the differences between the 'initiation' and 'reponsibility' approaches to community participation; Task 2--Participation definition-identify the existing institutions in the community and the process used by the community to make decisions, focusing specifically on water and/or health; Task 3--Community participation in design and planning; and Task 4--Change of project direction. (Lantz-PTT)
W89-05514

FRAMEWORK AND GUIDELINES FOR CARE WATER SUPPLY AND SANITATION PROJECTS,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
R. B. Isely, S. Faiia, J. Ashworth, R. Donovan, and J. Thomson.
Water and Sanitation for Health Project, Washington, DC. WASH Technical Report No. 40, June 1986. 163p, 4 fig, 3 tab, 78 ref, 3 append. AID Contract 5942-C-00-4085-00, Project 936-5942.

Descriptors: *Developing countries, *Standards, *Water supply, *Sanitation, *Management planning, Monitoring, Water management, Water treatment, Wastewater treatment.

Guidelines were developed based on CARE's long field experience in the water supply and sanitation sector. The guidelines provide a clear summary of CARE sector policies and their practical implications for particular types of projects. Because they make standard information readily available to those who need it and can use it, they should reduce project design and control costs. By relying on the guidelines, project designers, implementers, and evaluators can carry out their tasks more effectively. The guidelines are relatively comprehensive in scope, and emphasize an approach which integrates social with technical aspects in planning, implementing, monitoring, and evaluating sector projects and outline appropriate linkages between project components in different types of water and sanitation sector activities. They stress the importance of proper sequencing in project activities, especially in promoting user participation during all project phases. The guidelines provide technical data about existing water supply and sanitation systems to enable field personnel and users to make reasoned decisions on technical issues in selecting options, and offer suggestions about the kinds of follow-on activities which can result from water projects. The guidelines are not intended as a manual on construction techniques. They highlight major technical issues which may influence the choice of one system or approach over others. But other sources provide much fuller information on the practical details of building those systems. (Lantz-PTT)
W89-05515

ASSESSMENT OF THE OPERATIONS AND MAINTENANCE COMPONENT OF WATER SUPPLY PROJECTS,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
J. K. Jordan, P. Buijs, and A. S. Wyatt.
Water and Sanitation for Health Project, Washington, DC. WASH Technical Report No. 35, June 1986. 90p, 20 ref. AID Contract 5942-C-00-4085-00, Project 936-5942.

Descriptors: *Developing countries, *Water treatment facilities, *Maintenance, *Water conveyance, *Water management, Evaluation, Training, Water supply, Finances.

Effective operations and maintenance (O and M) of water systems in less developed countries requires systematic planning as the project is being designed. This planning, however, is frequently overlooked. Part of the reason for poor O and M is the lack of a planning tool that may be used by water system project designers to assess the likely effectiveness of the operations and maintenance components. A manual prepared to fill this need contains information concerning the operations and maintenance of water supply systems and four O and M assessment guides. The guides are organized in a question-and-answer format that addresses the critical elements involved in operating and maintaining a water system. These elements are as follows: institutional capability, system operations and maintenance, spare parts and supplies, logistics, finance, records, and human resources and training. (Lantz-PTT)
W89-05516

WATER SUPPLY AND SANITATION IN THE HEALTH SECTOR IN THE ASIA REGION: INFORMATION NEEDS AND PROGRAM PRIORITIES,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project. For primary bibliographic entry see Field 7A.
W89-05517

VALUE OF WATER SUPPLY AND SANITATION IN DEVELOPMENT: AN ASSESSMENT OF HEALTH-RELATED INTERVENTIONS,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
D. A. Okun.
Water and Sanitation for Health Project, Washington, DC. WASH Technical Report No. 43, September 1987. 50p, 12 tab, 43 ref, append. AID Contract 5942-C-00-4085-00, Project 936-5942.

Descriptors: *Water supply development, *Costs, *Public health, *Water management, *Sanitation, Economic aspects, Developing countries, Water treatment, Wastewater treatment.

Water supply and sanitation have, for more than a century, been perceived as the principal instrument for protecting communities against diarrheal disease. Today, however, oral rehydration therapy (ORT), a new and simple ministration that averts many deaths from diarrhea among children, is diverting attention from the importance of water supply and sanitation (WS and S) in developing nations. The strong attraction of ORT is its apparent low cost per diarrheal death averted in children when compared with WS and S. In addition, ORT saves the lives of young children at a time when they are most vulnerable and preserves lives until more lasting measures can be taken. WS and S, however, provides many more benefits that are essential to sustaining lives: prevent the cause of diarrhea; control many other water- and sanitation-related diseases; improve the delivery of primary health care; improve nutritional status; service health centers and schools; release women from the heavy and time-consuming burden of carrying water from distant sources; provide water for household gardens and animals; promote commercial activity; support other sectors, such as housing and industry; improve community organizations that can serve other purposes; and, most significantly, improve the quality of life in the community. Comparisons between WS and S and ORT are misleading because they have different objectives and provide different benefits. If infant mortality rates in the poorer developing countries, more than tenfold higher than in industrialized countries, are to be reduced, programs of WS and S introduced with active community participation and accompanied by hygiene education are absolutely essential. The costs are not high; $5 to $10 per capita annually will provide basic WS and S services. (Lantz-PTT)
W89-05518

WATER VENDING AND DEVELOPMENT: LESSONS FROM TWO COUNTRIES,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project. For primary bibliographic entry see Field 6C.
W89-05519

HYDROPNEUMATIC PUMP SYSTEM DEVELOPMENT,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project. For primary bibliographic entry see Field 8C.
W89-05520

COMMUNITY DEVELOPMENT WORKER TRAINING FOR THE SHABA REFUGEE WATER SUPPLY PROJECT IN ZAIRE,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project. For primary bibliographic entry see Field 6A.
W89-05521

TRAINING OF TRAINERS WORKSHOP AND TRAINING MATERIALS DEVELOPMENT FOR THE WATER AND SANITATION COMPONENT OF SANRU II,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project. For primary bibliographic entry see Field 6A.
W89-05522

RURAL WATER SUPPLY AND SANITATION PROGRAM IN THE SOLOMON ISLANDS,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
J. K. Jordan, and R. R. Capul.
Water and Sanitation for Health Project, Washington, DC. WASH Field Report No. 179, May 1986. 89p, 3 fig, 9 append. AID Contract 5942-C-00-4085-00, Project 936-5942.

Descriptors: *Developing countries, *Rural areas, *Water supply development, *Sanitation, *Solomon Islands, Management planning, Finances, Economic aspects, Public participation, Public health, Training, Maintenance, Water treatment, Wastewater treatment..

At the request of the US Agency for International Development/Suva (USAID/Suva) the Water and Sanitation for Health (WASH) Project sent a two-person team to Solomon Islands (SI) in January and February 1986 to assist USAID/Suva by recommending methods whereby USAID could best implement the Rural Water and Sanitation Project for Child Survival in the Solomon Islands. In addition, the Solomon Islands Government requested that the WASH team assess the effectiveness of the Rural Water and Sanitation (RWSS) Project which was started by the Solomon Islands Government in 1979. Conclusions included: (1) The Solomon Islands Government must decide if it wants to place greater emphasis on sanitation. If so it must recognize that fewer water systems can be constructed; (2) The Environmental Health Division should continue to administer the RWSS Program, but must implement a satisfactory management information system; (3) Implementing a program to maintain rural water systems is essential; and (4) The development and implementation of a research protocol to measure the health benefits of improved water systems in the Solomon Islands is not practical. Recommendations include: (1) The Ministry of Health and Medical Services should form a committee to make decisions on the direction of the RWSS Program with respect to sanitation; (2) Some of the funds currently allocated for materials should be used to provide more reliable transport for Environmental Health Division personnel; (3) The Solomon Islands Government should seek donor assistance to begin a program of developing community participation workshops for villages with water systems and for those that will receive new ones; (4) USAID should provide financial support and management for the training associated with the development of community participation workshops; and (5) USAID should not provide major support for materials to construct new water systems. Current donor aid is adequate to support this part of the program. Until simplified and practical methodologies are developed, USAID should not fund attempts to undertake research programs to assess the health benefits of improved water supplies to the rural people in the Solomon Islands. (Lantz-PTT)
W89-05523

PREPARATION OF A NATIONAL RURAL WATER SUPPLY AND SANITATION PLAN IN ZAIRE,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
D. B. Warner, and P. A. Stevens.
Water and Sanitation for Health Project, Washington, DC. WASH Field Report No. 184, May 1986. 35p, 3 append. AID Contract 5942-C-00-4085-00, Project 936-5942.

Descriptors: *Developing countries, *Rural areas, *Sanitation, *Water supply development, *Zaire, *Management planning, Finances, Public participation, Public health, Water treatment, Wastewater treatment.

At the request of the Government of Zaire (GOZ), two WASH consultants returned to Zaire from 13 to 24 April 1986 to assist a subcommittee of the

National Action Committee for Water and Sanitation (CNAEA) in preparing a national rural water and sanitation plan. The consultants worked with the subcommittee in reviewing the first draft of the plan. The conclusions of the consultants were: (1) Although the Rural Plan was incomplete by the end of April, the overall progress made by the subcommittee has been commendable; (2) A need exists for a permanent planning unit to be established; (3) A need exists for more rigorous leadership by the United Nations Development Programme within the United Nations community; (4) USAID personnel are needed to actively participate in the work of the CNAEA subcommittee in order to reinforce the health concerns in water and sanitation planning; (5) The SANRU Project offers a sound model for integrating water, sanitation, and health education. Recommendations include: (1) The current CNAEA subcommittee should be constituted as a permanent technical advisory unit to the CNAEA; (2) USAID should continue to actively support and participate in the planning work of the CNAEA subcommittee; and (3) USAID should encourage better coordination among the donor community. (Lantz-PTT)
W89-05524

PVO EFFECTIVENESS IN THE WATER SUPPLY AND SANITATION SECTOR,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
D. B. Warner, D. Campbell, and C. R. Hafner.
Water and Sanitation for Health Project, Washington, DC. WASH Field Report No. 183, April 1986. 10p, 4 ref. AID Contract 5942-C-00-4085-00, Project 936-5942.

Descriptors: *Developing countries, *Volunteers, *Water supply, *Water management, *Sanitation, *Water resources development, Public participation, Water treatment, Wastewater treatment.

A congressional inquiry was conducted into the effectiveness of private voluntary organizations (PVOs) in providing water and sanitation (WSS) services in developing countries. In August 1985, the House Appropriations Committee (House Report No. 99-252) requested a report on which PVOs would be affected by proposals that at least 25% of their international funding be obtained from private sources. The committee also requested that USAID update and expand an earlier study on the effectiveness of PVOs. The chapters of this report provide: (1) The general nature and extent of PVO activity in the sector, including key PVOs involved; (2) A summary of noteworthy PVO project examples in the sector, including an assessment of PVO impact and effectiveness; and (3) Conclusions about PVO strengths and weaknesses. Many PVOs have developed a long-term presence in various countries and because they are often apolitical, they can sometimes operate in countries where the U.S. government cannot provide direct assistance. PVOs can mobilize quickly when conditions require, use indigenous staff effectively, have low overhead and administrative costs, and have direct impact on the welfare of women and children by emphasizing WSS in rural areas. Several weaknesses of PVOs were identified, such as a lack of sufficient technical monitoring field operations difficult, and inattention to long-term maintenance needs of WSS systems. (Lantz-PTT)
W89-05525

EVALUATION OF THE WATER SUPPLY AND SANITATION COMPONENT OF THE ADB-SPONSORED RURAL HEALTH SERVICES PROJECT IN PAPUA NEW GUINEA,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
J. Haratani, J. S. Baker, and J. K. Jordan.
Water and Sanitation for Health Project, Washington, DC. WASH Field Report No. 182, June 1986. 148p, 8 tab, 28 photos, 24 ref, 14 append. AID Contract 5942-C-00-4085-00, Project 936-5942.

Descriptors: *Water management, *Sanitation, *Papua, *Water supply, *Developing countries, Public health, New Guinea, Rural areas, Evaluation, Training, Public participation, Economic aspects, Water conveyance, Water treatment, Wastewater treatment, Maintenance.

In November 1982, the Government of Papua New Guinea signed a loan agreement with the Asian Development Bank to fund a rural health services project covering 6 of the nation's 19 provinces. This project is referred to as ADB-1 in this report. The greatest shortcoming in project implementation is the lack of maintenance of water supply system. This results in an unacceptable rate of system failures. The problem of maintenance is closely tied to the lack of full community participation, and to the fact that the water supply and sanitation activity has traditionally operated as a separate program and still remains organizationally outside the mainstream of the ADB-1 project and receives inadequate attention and support. The officers in charge have not been trained for the program planning, budgeting, managing, engineering, and accounting roles they are expected to perform. Further difficulties include: (1) the necessary financial systems are in place but the rules governing their use are often ignored; (2) at the present rate of project implementation there will be a shortfall in expenditure of the water supply and sanitation budget; and (3) the decentralization of the government created a management vacuum which still has not been completely filled and is a constraint to effective project implementation. (Lantz-PTT)
W89-05526

TRAINING OF TRAINERS IN MALAWI'S HEALTH EDUCATION AND SANITATION PROMOTION (HESP) PROGRAM (PHASE TWO),
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
C. Liebler.
Water and Sanitation for Health Project, Washington, DC. WASH Field Report No. 185, June 1986. 75p, 7 append. AID Contract 5942-C-00-4085-00, Project 936-5942.

Descriptors: *Developing countries, *Training, *Education, *Malawi, *Sanitation, *Water management, Public health, Public participation.

At the request of the USAID Mission in Lilongwe and the Ministry of Health (MOH) of the Government of Malawi, the Water and Sanitation for Health (WASH) Project was authorized by USAID's Office of Health to send a consultant to Malawi in March 1986 to assist MOH trainers to design, prepare, conduct, manage, and evaluate two five-day workshops in health education methods for health surveillance assistants (HSAs), the field workers of the MOH. The purpose of the consultancy, which was planned in two phases (the first occurring in January 1986) was to increase the skills of newly selected MOH trainers in planning and conducting experiential job-related training programs for district level personnel within each region. A secondary purpose of this Phase Two consultancy was to equip HSAs with skills in health education methods especially as related to water and sanitation. Specific problem-centered training for the present, proved to be more effective than general preparation for the future. Careful attention must be given to maximizing opportunities for success in the design of an action training event, and consideration must be given to future replicability if long-range impact beyond the duration of the consultancy is to occur. This consideration requires an overall approach that pays attention to the goals of replicability and takes into account the realities, constraints, and opportunities within the setting. (Lantz-PTT)
W89-05528

TECHNOLOGICAL APPROACHES TO REMOVING TOXIC CONTAMINANTS,
Environmental Protection Agency, Cincinnati, OH. Drinking Water Research Div.
R. M. Clark.
In: Planning for Groundwater Protection. Academic Press, New York, NY, 1987. p 89-123, 25 tab, 17 ref.

Descriptors: *Water treatment, *Toxicity, *Pollutants, *Drinking water, *Water supply, *Water treatment, *Aeration, Municipal water, Water quality, Costs, Flocculation, Filtration, Sedimentation, Sludge, Ion exchange, Resins, Cation exchange, Activated carbon, Adsorption, Contamination.

Alternatives for supplying drinking water to a municipality when its normal supply is contaminated. The term alternative refers to any alternate source and includes both new supplies or treatment of the existing supply. The technological approaches described are often used when an existing supply is found to be contaminated. Among the various alternatives that might be considered are development of new or existing water resources, blending of a new and contaminated water supply to achieve safe levels, treatment at the well head or each point of consumption, connection to alternative existing municipal or private supplies, oversized community storage facilities to compensate for loss of existing system capacity, and alteration of existing groundwater flows. (See W89-05600) (Stoehr-PTT)
W89-05604

STUDY OF POSSIBLE ECONOMICAL WAYS OF REMOVING RADIUM FROM DRINKING WATER,
Iowa Univ., Iowa City.
R. L. Valentine, R. C. Splinter, T. S. Mulholland, J. M. Baker, and T. M. Nogaj.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-158464. Price codes: A06 in paper copy, A01 in microfiche. Report No. EPA/600/2-08/009, January 1988. 88p, 87 fig, 9 tab, 38 ref, append. EPA Contract CR-810575-01.

Descriptors: *Drinking water, *Water treatment, *Economic aspects, *Radium removal, Iron oxide, Manganese oxide, Sand filtration, Adsorption, Hydrogen ion concentration, Chemical precipitation.

Variables that control the incidental removal of radium that has been observed to occur as a consequence of treatment to remove iron by oxidation - sand filtration were studied. The possibility of exploiting these factors to provide an inexpensive means of removing radium using existing or modified iron removal facilities was also evaluated. Radium sorption to hydrous manganese oxides and the potential of radium sorption to filter sand as a novel removal technology were also assessed. Results showed that radium sorption to iron and manganese oxides and filter sand appears to be controlled primarily by the presence of calcium and manganese, which are believed to compete for sorption sites. Significant sorption of radium to iron oxides at typical iron concentrations in natural waters would require an excessively high pH. Radium removals by freshly precipitated hydrous manganese oxides were much greater than removals by iron oxides only. This suggests that sorption to manganese oxides could be exploited to remove radium if iron did not interfere. Filter sand has a potential capacity to sorb significant concentrations of radium at typical hardness concentrations if the capacity is maintained by periodically rinsing the sand with a dilute acid. (Author's abstract)
W89-05763

WATER AND WASTEWATER TREATMENT INVENTORY AND THE PERCEPTION OF WASTEWATER ENGINEERS ON CONSIDERATIONS AFFECTING TREATMENT ALTERNATIVES,
Air Force Inst. of Tech., Wright-Patterson AFB, OH.
For primary bibliographic entry see Field 5D.
W89-05764

5G. Water Quality Control

RECOMMENDED PROCEDURE FOR EVALUATING THE EFFECTS OF SPILLS OF HAZARDOUS MATERIALS ON GROUND WATER QUALITY IN KARST TERRANES,
National Park Service, Mammoth Cave, KY.
J. F. Quinlan.
IN: Proceedings of the Environmental Problems in Karst Terranes and Their Solutions Conference.

National Water Well Association, Dublin, OH. 1986. p 183-196, 44 ref.

Descriptors: *Water pollution prevention, *Groundwater pollution, *Hazardous materials, *Risks, *Water pollution effects, *Karst, Streams, Alternative planning.

To mitigate or prevent adverse effects of spills of hazardous materials, the following pre-spill actions should be taken where risk probability, risk consequences, and pre-spill costs justify doing so: (1) identify significant springs in karst areas sensitive to spill occurrence; (2) acquire, compile, and interpret regional potentiometric data; (3) do reconnaissance dye-tracing; (4) delineate ground water basins; (5) compile maps which summarize data; (6) evaluate alternative responses to various hypothetical scenarios of spills; (7) establish lines of communication with local, state and federal agencies that may be involved with response to a spill; (8) maintain and update a call-out list of analytical capabilities and fees of local state- or EPA-certified laboratories; and (9) have response materials on hand. After a spill the following actions should be undertaken, as appropriate: (1) notify local, state and federal spill-response agencies; (2) call CHEMTREC if a truck or train is involved; (3) construct an earth dam and prevent discharge into a sinkhole; (4) temporarily quarantine wells and springs that might be adversely affected by the spill; (5) run dye-tests from the spill site nd also from a nearby sinking stream; (6) analyze water samples from springs and cave streams; (7) preserve chain-of-custody of water samples; (8) set plankton nets at springs and cave streams; and (9) calculate mass-balance of spilled material. These actions supplement standard spill-response procedures. (See also W89-04586) (Author's abstract)
W89-04595

DYE TRACING STUDIES OF THE FOUNTAIN, MINNESOTA SEWAGE SYSTEM,
Minnesota Univ., Minneapolis. Dept. of Geology and Geophysics.
For primary bibliographic entry see Field 5E.
W89-04598

USE OF FRACTURE TRACE ANALYSIS IN KARST TERRANES FOR ENVIRONMENTAL REMEDIAL ACTION PLANNING: A CASE STUDY,
Bionetics Corp., Warrenton, VA.
For primary bibliographic entry see Field 5B.
W89-04599

GROUND WATER PROBLEMS ASSOCIATED WITH A MUNICIPAL LANDFILL IN THE NASHVILLE DOME REGION OF ALABAMA,
Alabama Univ. in Huntsville. Civil Engineering Program.
For primary bibliographic entry see Field 5B.
W89-04601

CASE STUDY: REMEDIATION OF KARST COLLAPSES IN WATER/WASTEWATER IMPOUNDMENTS,
Syntex Agribusiness, Inc., Springfield, MO.
G. J. Pendergrass.
IN: Proceedings of the Environmental Problems in Karst Terranes and Their Solutions Conference. National Water Well Association, Dublin, OH. 1986. p 378-386, 3 fig.

Descriptors: *Water pollution control, *Missouri, *Settling basins, *Sinkholes, *Waste disposal, *Karst hydrology, *Subsidence, *Engineering, Civil engineering, Electric powerplants, Ponds.

A simple, economic means of remediation of a hole in an ash disposal pond which was successful in Southwestern Missouri karst, involved reconstruction of bedrock and reconstruction of the soil. City Utilities' Southwest Power Station is sited on a sinkhole plain within the ground watershed of Rader Spring. The plant uses a two-celled settling pond for storage of hydraulically-transferred bottom ash. Extensive measures were taken during site exploration and construction to detect and remediate potential karst collapses. Leakage was reported in 1981. A site inspection showed a hole, approximately 16 inches in diameter, within the floor of cell No. 1. Slight subsidence cracking was observed to a distance of three feet from the hole. The failure had occurred as the cell was being refilled, directly following a cycle of ash removal. The remediation project was completed using plant personnel and equipment. All materials used in the remediation were available locally. Time required to complete the work was approximately two weeks. The pond was returned to normal service, and repairs have performed satisfactorily. (See also W89-04586) (Hammond-PTT)
W89-04605

AQUIFER PROTECTION PLANNING FOR CRITICAL KARST GROUND WATER SUPPLIES; A COORDINATED LOCAL AND STATE APPROACH FOR KENTUCKY,
Kentucky Natural Resources and Environmental Protection Cabinet, Frankfurt. Div. of Water.
G. M. Schindel.
IN: Proceedings of the Environmental Problems in Karst Terranes and Their Solutions Conference. National Water Well Association, Dublin, OH. 1986. p 425-434, 1 tab, 6 ref.

Descriptors: *Water quality management, *Kentucky, *Aquifers, *Karst *Groundwater pollution, *Municipal water, *Data acquisition, *Planning, Surface water, Environmental protection, Groundwater recharge, Regulations, Public policy.

An aquifer protection plan outlines a strategy to protect critical karst groundwater supplies. The planning process must be a coordinated local and state effort. The aquifer protection planning process is divided into two major areas: physical data collection and evaluation and cultural resource analysis. A physical data collection and evaluation program includes the delineation of recharge areas, an evaluation of water supply quality and quantity, detection of contaminants and location of their sources, and the determination of remedial measures for contaminant abatement. A cultural resources analysis program involves the survey of existing and planned development, the evaluation of existing regulations and management practices, and a review of possible strategy actions. The physical data collection and cultural resources analysis programs will provide a coordinated and comprehensive groundwater protection plan for local and state officials. (See also W89-04586) (Author's abstract)
W89-04608

TYPHOID OUTBRAKE AT PARADISE MILLS PUBLIC HOUSING COMPLEX,
Environmental Protection Agency, San Juan, PR. Caribbean Office.
For primary bibliographic entry see Field 5C.
W89-04666

MONITORING OF GROUNDWATER RESOURCES OR AN OUNCE OF PREVENTION IS WORTH A MILLION GALLONS OF WATER RESOURCES,
Terra-Vac, Dorado, PR.
J. J. Malot.
IN: Third Caribbean Islands Water Resources Congress. Proceedings of a Symposium held in St. Thomas, U.S. Virgin Islands, July 22-25, 1986. p 75-78.

Descriptors: *Water quality control, *Groundwater quality, *Monitoring, Water pollution prevention, Hazardous wastes, Groundwater recharge.

Small amounts of common cleaning solvents, pesticides, fertilizers, gasoline and other petroleum products can ruin a valuable water resource. Transportation, storage of these chemicals, and protection of water resources must be a constant concern. Protection and maximum utilization of water resources need not be sacrificed by the common occurrence and use of potentially hazardous chemicals. However, without frequent and effective monitoring to provide early detection, the cleanup of water resources due to inadvertant spills, leaks and misuse of hazardous chemicals will cost much more than the cost of monitoring. The most effective method of monitoring is at the source. Special attention to groundwater recharge areas, well fields, runoff control in watersheds used for drinking supplies and rapid spill response are necessary to protect water resources. A new method of monitoring underground storage tanks and industrial activities in various hydrogeological settings has been developed that can also be used to recover contaminants before they reach the water table. The system uses a monitoring/extraction well permanently installed near the underground tanks which is fitted with a vacuum system which extracts subsurface vapors. On-site analysis of vapors detects and quantifies any volatile contaminants caused by a leak or a spill. (See also W89-04665) (Author's abstract)
W89-04678

PROCEEDINGS OF THE INTERNATIONAL SYMPOSIUM ON THE HYDROLOGY OF WETLANDS IN TEMPERATE AND COLD REGIONS.
For primary bibliographic entry see Field 2H.
W89-04689

WETLAND CONSERVATION IN FINLAND,
Ministry of the Environment, Helsinki (Finland).
For primary bibliographic entry see Field 2H.
W89-04691

ECOLOGICAL FEATURES OF AN ARTIFICIAL WETLANDS AREA,
Vsesoyuznyi Nauchno-Issledovatel'skii Inst. Gidrotekhniki i Melioratsii, Kharkov (USSR).
V. G. Magmedov, and L. I. Yakovleva.
IN: Proceedings of the International Symposium on the Hydrology of Wetlands in Temperate and Cold Regions. Joensuu, Finland, 6-8 June 1988. Vol. 1. The Academy of Finland, Helsinki, Finland. 1988. p 72-75, 6 ref.

Descriptors: *Water quality control, *Biological filters, *Water pollution effects, *Wetlands, *Environmental protection, Biological properties, Chemical properties, Macrophytes, Bacteria, Phytoplankton, Benthos, Soil bacteria, Algae, Sulfates, Ammonia, Nitrates, Nitrogen, Chlorides, Hydrogen ion concentration, Heavy metals, Suspended solids, Marshes, Species composition, Population dynamics, Effluents.

The three main hydrobiochemical zones of artificially-created wetland ecosystems are the water column, the contact zone (bottom sediments), and the filtering soil layer. In a four-year laboratory and field study using hydrogeological, hydrobiological, biological, and physiocochemical methods, vertically-delineated and quantitatively and qualitatively characterized ecological groupings were found in each zone. The dynamics of development of macrophytes, bacterio- and phytoplankton, periphyton, bacterio-, phyto-, and zoobenthos, soil microflora, and soil algae were investigated. It was found that anthropogenic loads lead to formation of a specific composition of the biogeocenosis ecological groupings. Sulfates, ammonium and nitrate nitrogen concentrations up to 1000 mg/L, chlorides up to 1500 mg/L, suspended solids up to 300 mg/L, fluctuations in pH (of 3-5 units) and presence in effluents of heavy metal ions did not suppress the wetlands biocenosis. The investigations demonstrated that wetlands are not only an important link between surface and groundwaters, but also that they can play an essential role in environmental protection. (See also W89-04689) (Author's abstract)
W89-04701

MODIFICATION OF WATER QUALITY IN IVUJIVIK (NORTHERN QUEBEC, CANADA),
Quebec Univ., Montreal.
For primary bibliographic entry see Field 5D.
W89-04720

ENVIRONMENTAL ASSESSMENT OF PEAT-LAND DEVELOPMENT OPERATIONS IN NEWFOUNDLAND,
Lakehead Univ., Thunder Bay (Ontario). Dept. of Civil Engineering.
For primary bibliographic entry see Field 4C.
W89-04727

ROLE OF ACUTE TOXICITY BIOASSAYS IN THE REMEDIAL ACTION PROCESS AT HAZARDOUS WASTE SITES,
Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 5A.
W89-04747

SUPERFUND RECORD OF DECISION: MINKER STOUT/ROMAINE CREEK, MO.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-173000. Price codes: A03 in paper copy, A01 in microfiche. Report No. EPA/ROD/RO7-87/007, September 1987. 16 p, 1 tab.

Descriptors: *Water pollution sources, *Water pollution treatment, *Remedial action, *Superfund, *Water quality, *Stream degradation, *Stream pollution, Dioxin, Missouri, Romaine Creek, Chlorinated hydrocarbons, Soil contamination.

The Romaine Creek portion of the Minker/Stout/Romaine Creek, located in Jefferson County, Missouri, starts at the Minker area and flows 4.6 mi. to its confluence with Saline Creek. Romaine Creek is located in a rural residential area, and is not used for municipal, industrial or domestic purposes. However, in the late 1960s and early 1970s residues contaminated with 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) were mixed with waste oils and sprayed as a dust suppressant on a nearby horse arena. These contaminated soils were later used as fill in a ravine on the Minker property, and since 1973, much of this soil has eroded into Romaine Creek. In 1982, contaminated soils above 1 ug/kg TCDD were excavated from the Minker portion of the site. The selected interim remedial measure for the Romaine Creek portion of this site includes: excavation and temporary onsite storage of soils and sediments contaminated with $>$ 1 ug/kg TCDD; and backfilling of the excavated areas with clean material suitable for the establishment of a natural stream bed. The estimated present worth cost for this remedial action is $4,488,000, with an annual operation and maintenance cost of $28,000. (White-Reimer-PTT)
W89-04750

IMPROVED LABORATORY DISPERSANT EFFECTIVENESS TEST,
Environmental Protection Agency, Cincinnati, OH. Office of Research and Development.
For primary bibliographic entry see Field 7B.
W89-04752

SURFACTANT-ENHANCED IN SITU SOILS WASHING,
Environmental Protection Agency, Edison, NJ. Hazardous Waste Engineering Research Lab.
J. Nash, R. P. Traver, and D. C. Downey.
Available from the National Technical Information Service, Springield, VA 22161, as ADA-188066. Price codes: A04 in paper copy, A01 in microfiche. Report No. ESL-TR-87-18, September 1987. 55p, 15 fig, 10 tab, 4 ref, 2 append.

Descriptors: *Cleanup, *Water pollution treatment, *Soil contamination, *Groundwater pollution, *Surfactants, *Petroleum products, Soil washing, Total organic carbon, Packed-tower air stripper, Soil chemistry.

The feasibility of using surfactants to enhance the washing of petroleum and solvent contaminated soils was examined. A pilot-scale test of in situ soils washing was performed at an abandoned fire training area using several surfactant solutions. The results indicate in situ soils washing is not a proven and reliable remediation technology because it is less effective than laboratory column methods, repeated washings led to a reduction in soil permeability, and the cost of using synthetic surfactants is very high. The groundwater from the site was successfully treated using a series of chemical pretreatments and a packed-tower air stripper. (White-Reimer-PTT)
W89-04753

ALLOWABLE RESIDUAL CONTAMINATION LEVELS OF RADIONUCLIDES IN SOIL FROM PATHWAY ANALYSIS,
Oak Ridge National Lab., TN. Environmental Sciences Div.
For primary bibliographic entry see Field 5A.
W89-04754

GEOCHEMICAL AND STATISTICAL APPROACH FOR ASSESSING METAL POLLUTION IN COASTAL SEDIMENTS,
Florida State Dept. of Environmental Regulation, Tallahassee.
For primary bibliographic entry see Field 5A.
W89-04761

ANALYTICAL TECHNIQUES AND RESIDUALS MANAGEMENT IN WATER POLLUTION CONTROL SPECIALTY CONFERENCE APRIL 19-20, 1988.
Proceedings. Water Pollution Control Federation, Alexandria, VA 22314-1994. WCPF Specialty Conference Series 261p.

Descriptors: *Conferences, *Water pollution control, *Sludge disposal, *Wastewater analysis, *Pollutant identification, Hazardous materials, Quality control, Data processing.

This proceedings covers two conferences that occurred April 19-20, 1988, in Atlanta, Georgia: an analytical techniques conference and a residuals management conference. Representatives of wastewater treatment authorities, consulting engineers, researchers, and federal representatives presented papers covering the following topics: practical laboratory techniques for priority pollutant analysis; hazardous waste testing procedures; laboratory quality control and data handling; testing techniques in microbiology and biology; wastewater sludge disposal and composting; land application of sludges; sludge processing; and effects of disposed sludge on soils. (See W89-04183 thru W89-04815) (Rochester-PTT)
W89-04782

MASSACHUSETTS WATER RESOURCES AUTHORITY: INTERIM SLUDGE MANAGEMENT PROGRAM,
Massachusetts Water Resources Authority, Boston, MA. Residuals Management Program.
For primary bibliographic entry see Field 5E.
W89-04802

BIOREMEDIATION OF CONTAMINATED SOILS,
Texas Univ. at Austin. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W89-04810

EFFECTS OF SEWAGE SLUDGE ON LEACHATES AND GAS FROM SLUDGE-REFUSE LANDFILLS,
Environmental Protection Agency, Cincinnati, OH. Water Engineering Research Lab.
For primary bibliographic entry see Field 5E.
W89-04812

EPA ACTIVITIES RELATED TO SOURCES OF GROUND-WATER CONTAMINATION.
Environmental Protection Agency, Washington, DC. Office of Ground-Water Protection.
For primary bibliographic entry see Field 2F.
W89-04851

GUIDELINES FOR DELINEATION OF WELLHEAD PROTECTION AREAS.
Environmental Protection Agency, Washington, DC.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-111430. Price codes: A10 in paper copy, A01 in microfiche. June 22, 1987. 188p, 37 fig, 18 tab, 74 ref, 4 append.

Descriptors: *Groundwater protection, *Water pollution prevention, Groundwater management, Groundwater quality, Geohydrology, Model studies, Wells, State jurisdiction, Public policy.

The Guidelines, an appendix to the 'Guidance for Applicants for State Wellhead Protection Program Assistance Funds under the Safe Drinking Act,' are intended to provide technical assistance to State and local governments in their efforts to delineate Wellhead Protection Areas. In addition to outlining the geohydrologic and contaminant controls over Wellhead Protection Area delineation, a variety of delineation criteria and methodologies believed to be most effective in mapping Wellhead Protection Areas. Specific attention is given to criteria and method selection are described. The appendices include: a summary of current United States and European programs, a comparative analysis of delineation approaches using data from four States (Massachusetts, Florida, Colorado, and Connecticut), a glossary of terms, and an assessment of the available computer-based groundwater modeling routines. (Author's abstract)
W89-04852

NATIONAL ACID PRECIPITATION ASSESSMENT PROGRAM,
For primary bibliographic entry see Field 5A.
W89-04862

POTENTIAL EMISSIONS REDUCTIONS FROM CONSERVATION, LOAD MANAGEMENT, AND ALTERNATIVE POWER,
M. Kahal.
IN: Acid Deposition in Maryland: The Status of Knowledge in 1987. Maryland Power Plant Research Program Report No. AD-88-1, January 1988. p 165-170, 12 ref.

Descriptors: *Energy conservation, *Alternative planning, *Acid rain, *Maryland, *Air pollution control, *Water pollution prevention, Sulfur dioxide, Electric power production, Pollution load, Regional planning.

The contribution that conservation, load management, and alternative power might make toward lessening sulfur dioxide emissions from Maryland's power plants remains speculative and difficult to quantify. Only limited information is available at the present time on conservation potentials in Maryland. Based upon this information and comprehensive studies from other parts of the country, it is assumed that conservation potential for the Potomac Electric Power Company (PEPCO) and Baltimore Gas and Electric Company (BG and E) system is five to ten percent of actual 1986 electricity usage. Both PEPCO and BG and E participate as full members in the Pennsylvania, New Jersey, Maryland Interconnection (PJM), a highly integrated, multi-state power pool. Thus conservation or alternative power development in Maryland may not achieve a corresponding displacement of utility power generation and hence emissions reduction in the state. Therefore, generation displacement may take place elsewhere in the region. This fact re-emphasizes the point that acid deposition does not respect state borders and can best be understood in a regional context. (See also W89-04861) (Lantz-PTT)
W89-04869

MITIGATION,
A. Janicki, and H. Greening.
IN: Acid Deposition in Maryland: The Status of Knowledge in 1987. Maryland Power Plant Research Program Report No. AD-88-1, January 1988. p 171-181, 2 tab, 18 ref.

Descriptors: *Rehabilitation, *Acid rain effects, *Lake restoration, *Water pollution treatment,

*Water quality control, *Acidification, Calcium carbonate, Lime, Neutralization, Chesapeake Bay, Ecosystems, Environmental effects.

Mitigation programs have been in effect in northern Europe and Canada for several years. These programs are continuing and generally report success in maintaining suitable water quality. In the United States, several programs have been initiated within the last five years, primarily as research and demonstration projects. A variety of techniques and materials is presently being used for lake and stream neutralization. A very fine calcium carbonate (calcite) slurry appears to be one of the most effective liming materials, and is being used in both lake and stream programs. A common problem has been reported in any of the ongoing mitigation programs. In lakes, the nearshore or littoral zone is often not mitigated by whole-lake liming and can be adversely affected by snowmelt or runoff. The nearshore zone is inhabited by acid-sensitive early life stages of fish and invertebrates subject to non-mitigated acidic runoff. A similar problem can occur in streams. Episodic acidic events associated with snowmelt or runoff and high flow conditions may not be treated completely with static stream mitigation techniques. In Maryland, two ongoing stream projects are addressing the use of stream dosers to ameliorate episodic acid events. Mitigation technology is especially important for tributaries of the Chesapeake Bay, where streams serve as spawning grounds for commercially and recreationally important anadromous fish species during typically high stream flow periods. Initial results have not been conclusive, but results from later years of these projects will be used to determine the efficacy of stream liming techniques. (See also W89-04861) (Lantz-PTT)
W89-04870

FEDERAL AND STATE INITIATIVES,
D. Brown, and M. Bowman.
IN: Acid Deposition in Maryland: The Status of Knowledge in 1987. Maryland Power Plant Research Program Report No. AD-88-1, January 1988. p 183-218, 5 tab, 26 ref.

Descriptors: *Air pollution, *Legislation, *Federal government, *State government, *Regulations, *Acid rain, Maryland, Cost, Economic aspects, Permits, Waste disposal, Air pollution, Acidification, Effluent charges, Cost sharing, Nonstructural alternatives.

Since 1980 Congress has considered many amendments to the Clean Air Act to control and reduce acid deposition. These bills have generally proposed reducing sulfur dioxide emissions by between 8 and 12 million tons and nitrogen oxide emissions by between 4 and 6 million tons. To date, a bill has not been enacted into law. Recent bills rely more frequently on reducing average emission rates. Major attributes of proposed control legislation have remained relatively consistent through time. The control region is either the 31 eastern states of the 48 contiguous states. A wide range of control technologies and strategies are allowed, although some bills have specified particular methods such as flue gas desulfurization (scrubbers), low sulfur coal combustion, or precombustion coal cleaning. Control costs have either been allowed to be paid by the source (polluter pays) or through an emissions tax or subsidy program (cost sharing). The manner in which proposed bills treat certain aspects of control requirements could have major effects on the implementation of an emission reduction program. A reduction in the average emission rate allows greater flexibility to achieve emissions reductions in a cost-effective manner compared with imposition of a specified tonnage reduction. Interstate emissions trading provisions would make a control program much more difficult to implement and monitor due to regulatory and legislative conflicts between states. An exception to this might be allowing interstate trading within a utility system. Several issues discussed in last year's report remain unchanged. These include power pooling, intra- and interstate regulatory agency coordination, facility permitting, and solid wastes disposal. (See also W89-04861) (Lantz-PTT)
W89-04871

EFFECTIVENESS OF BMPS FOR STORMWATER MANAGEMENT IN URBANIZED WATERSHEDS,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Civil Engineering.
C. Y. Kuo, G. V. Loganathan, W. E. Cox, S. P. Shrestha, and K. J. Ying.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-167309. Price codes: A06 in paper copy, A01 in microfiche. VPI-VWRRC-BULL 159, 4.5C, January 1988. 121p, 37 fig, 16 tab, 39 ref.

Descriptors: *Urban watersheds, *Urban runoff, *Water pollution control, *Best management practice, *Stormwater, *Management planning, *Model studies, Simulation analysis, Water quality, Storm runoff, Urban areas.

The Illinois Urban Drainage Area Simulator (ILLUDAS) has been modified for continuous simulation and a water quality module has been added to it. The continuous simulation model updates the Antecedent Moisture Condition (AMC) based on the rainfall information up to 120 hours prior to the beginning of a storm and the information on the number of dry days between storms is utilized to compute the pollutant build-up which also depends on the street sweeping interval. The water quality module utilizes the dust and dirt method of STORM to compute pollutant accumulated on the watershed surface. Pollutant washoff is then computed based on the assumption of first-order kinetics. Features have been added to simulate the effect of best management practice (BMP) structures. Infiltration trenches and detention ponds have been considered in this study. An optimization scheme has been adopted to optimally size and locate the detention structures within the watershed The model has been verified using the observed data from the Upper Holmes Run Watershed in Northern Virginia and a hypothetical watershed, basin Alpha, originally described in ILLUDAS. An institutional framework for urban stormwater management is delineated. The role of federal, state, and local agencies in urban stormwater management is discussed. (Author's abstract)
W89-04873

PESTICIDE ASSESSMENT GUIDELINES SUBDIVISION N, CHEMISTRY: ENVIRONMENTAL FATE. SERIES 161-2 AND 161-3, PHOTOLYSIS STUDIES. ADDENDUM 4 ON DATA REPORTING,
Environmental Protection Agency, Washington, DC. Office of Pesticide Programs.
For primary bibliographic entry see Field 5B.
W89-04874

PESTICIDE ASSESSMENT GUIDELINES SUBDIVISION N, CHEMISTRY: ENVIRONMENTAL FATE. SERIES 161-1, HYDROLYSIS STUDIES ADDENDUM 3 ON DATA REPORTING,
Environmental Protection Agency, Washington, DC. Office of Pesticide Programs.
For primary bibliographic entry see Field 5B.
W89-04875

MUNICIPAL SLUDGE MANAGEMENT PLANNING AND POLICY OPTIONS,
E and A Environmental Consultants, Inc., Stoughton, MA.
For primary bibliographic entry see Field 5D.
W89-04883

EFFECTS OF DETENTION ON WATER QUALITY OF TWO STORMWATER DETENTION PONDS RECEIVING HIGHWAY SURFACE RUNOFF IN JACKSONVILLE, FLORIDA,
Geological Survey, Tallahassee, FL. Water Resources Div.
P. S. Hampson.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, Co 80225. USGS Water Resources Investigations Report 86-4151. 1986. 69p, 20 fig, 16 tab, 34 ref, 2 append.

Descriptors: *Water quality, *Water pollution prevention, *Highway effects, *Detention reservoirs, *Storm runoff, *Urban runoff, Heavy metals, Nutrients, Rainfall, Seasonal variation, Sedimentation, Water quality, Groundwater, Sampling, Ponds.

Water and sediment samples were analyzed for major chemical constituents, nutrients, and heavy metals following ten storm events at two stormwater detention ponds that receive highway surface runoff in the Jacksonville, Florida, metropolitan area. The purpose of the sampling program was to detect changes in constituent concentration with time of detention within the pond system. Statistical inference of a relation with total rainfall was found in the initial concentrations of 11 constituents and with antecedent dry period for the initial concentrations of 3 constituents. Based on graphical examination and factor analysis, constituent behavior with time could be grouped into five relatively independent processes for one of the ponds. The processes were (1) interaction with shallow groundwater systems, (2) solubilization of bottom materials, (3) nutrient uptake, (4) seasonal changes in precipitation, and (5) sedimentation. Most of the observed water-quality changes in the ponds were virtually complete within 3 days following the storm event. (Author's abstract)
W89-04929

MIDWEST (U.S.A.) RESERVOIR WATER QUALITY MODIFICATION: II. OXYGEN-DEMANDING PARAMETERS,
Iowa Dept. of Natural Resources, Des Moines.
V. I. Okereke, E. R. Baumann, T. A. Austin, and D. S. Lutz.
Water, Air, and Soil Pollution WAPLAC, Vol. 37, No. 3-4 p 325-341, February 1988. 3 fig, 5 tab, 23 ref.

Descriptors: *Water quality, *Water quality control, *Reservoirs, *Low-flow augmentation, *Biological oxygen demand, *Chemical oxygen demand, States, Structure, Water sampling, Ammonia, Iowa, Flood-control storage, Annual runoff, Nonpoint pollution sources.

The impact of a flood control, low flow augmentation reservoir in the Midwestern part of the United Stated on biological oxygen demand, chemical oxygen demand and ammonia was evaluated. Fifteen years of weekly water quality data (9 years before impoundment and 6 years after impoundment) from four sampling stations upstream and downstream of the reservoir were available for analysis. The annual loading rates of these parameters (kg per ha per year) were found to correlate well with annual runoff (cm per year). Besides, the reservoir was found to have had a significant and beneficial impact on the downstream loading rates of biological oxygen demand and chemical oxygen demand, which were reduced by 55% and 75%, respectively. As for ammonia, the results indicate that its annual loadings at downstream locations were not significantly affected by the reservoir. Average non-point source contributions of biological oxygen demand and ammonia loadings into the system were found to be about 80% and 55%, respectively. (See W89-04974 and W89-04976) (Author's abstract)
W89-04975

ALKALINITY DESTRUCTION BY SEDIMENT ORGANIC MATTER DISSOLUTION DURING NEUTRALIZATION OF ACIDIFIED LAKES,
Cornell Univ., Ithaca, NY. Dept. of Environmental Engineering.
For primary bibliographic entry see Field 5B.
W89-04987

CRITERIA FOR EVALUATING THE RELIABILITY OF LITERATURE DATA ON ENVIRONMENTAL PROCESS CONSTANTS,
Environmental Research Lab., Athens, GA.
For primary bibliographic entry see Field 10D.
W89-05048

OPTIMIZATION OF STORM WATER STORAGE-RELEASE STRATEGIES,
Syracuse Univ., NY. Dept. of Civil Engineering.

S. J. Nix, and J. P. Heaney.
Water Resources Research WRERAO, Vol. 24, No. 11, p 1831-1838, November 1988. 6 fig, 1 tab, 31 ref.

Descriptors: *Storm water, *Water storage, *Storm runoff, *Urban runoff, *Water quality management, *Water pollution control, Graphical analysis, Numerical analysis, Computer models, Model studies.

Storage-release systems, are often used to improve the quality of urban storm water. Analytical methods to determine optimal storm water storage-release strategies are difficult to apply because of difficulties in providing accurate functional representations of the problem components and in solving nonlinear programming problems with economies of scale. In order to circumvent these obstacles robust procedures for selecting an optimal storage-release strategy are presented. One method takes a graphical approach; the other is based on an application of microcomputer-based spreadsheet and spatial analysis software. Both methods are demonstrated with a hypothetical scenario. A deterministic computer model was used to generate runoff from a small watershed and simulated the performance of a simple storage - release system. The information provided by the model was used to construct the production function. Then, the graphical and numerical techniques were used to find the optimal designs for various removal percentages. The results produced by the two techniques were consistent. (Sand-PTT)
W89-05053

BENEFITS OF INCREASED STREAMFLOW: THE CASE OF THE JOHN DAY RIVER STEELHEAD FISHERY,
Oregon State Univ., Corvallis. Dept. of Agricultural and Resource Economics.
For primary bibliographic entry see Field 6D.
W89-05054

RESPONSE OF THE PHYTOPLANKTON COMMUNITY TO THERAPY MEASURES IN A HIGHLY EUTROPHIC URBAN LAKE (SCHLACHTENSEE, BERLIN),
I. Chorus, and E. Wessler.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IVTLAP, Vol. 23, No. 2, p 719-728, August 1988. 5 fig, 3 tab, 24 ref.

Descriptors: *Limnology, *Model studies, *Phytoplankton, *Seasonal variation, *Lake restoration, *Schlachtensee, *West Germany, Berlin, Stormwater, Primary production, Hypertrophy, Phosphorus removal, Eutrophic lakes, Epilimnion, Hydrography, Chlorophyll a, Biomass, Primary production, Stratification.

Knowledge of mechanisms determining plankton seasonality and changes of this periodicity is of value for limnologists working on lakes under therapy. In 1986, the Plankton Ecology Group published a model attempting to explain and predict seasonal succession of plankton in freshwater. Data on plankton, primary production, and water chemistry were compiled for Schlachtensee, a lake under therapy in Berlin (West) Germany, situated at the border of a forest. Formerly dependent on ground water, it has been fed since the turn of the century by nutrient rich epilimnetic water from lake Wannsee. Stormwater runoff brings further loading. During the past decades, Schlachtensee has become hypertrophic. Therapy has been applied since autumn of 1981. It consists of the precipitation of phosphorus with FeCl3 or occasionally AlSO4 and filtration of the precipitate in a phosphorus elimination plant at the lake's main inflow. The treated water is flushed into the epilimnion of the southern part of the lake. This has led to a reduction of the external phosphorus load. The internal nutrient load is reduced by removal of phosphorus rich hypolimnetic water during late summer before autumnal overturn. Both treatments have led to a decrease of total phosphorus during spring overturn. Water input into Schlachtensee was similar in the years before and during therapy with the shortest renewal time of the epilimnion during summer stratification. Phytoplankton densities showed no response to the reduction of total phosphorus concentrations during the first three years of restoration, but a rather sudden switch to consistently lower biomass densities in 1985 and 1986. (Davis-PTT)
W89-05165

LONG-TERM DYNAMICS OF PLANKTON COMMUNITIES IN LAGO MAGGIORE (N. ITALY),
Istituto Italiano di Idrobiologia, Pallanza (Italy).
R. de Bernardi, G. Giussani, M. Manca, and D. Ruggiu.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IVTLAP, Vol. 23, No. 2, p 729-733, August 1988. 5 fig, 8 ref.

Descriptors: *Plankton, *Lake restoration, *Water pollution effects, *Eutrophic lakes, *Biomass, Lake Maggiore, Italy, Subalpine lakes, Phosphorus, Detergents, Primary production, Chlorophyll a, Zooplankton, Fish.

Lake Maggiore, the second largest Italian subalpine lake has, since the end of the 50's, undergone rapid changes in trophic state. The lake has passed from oligotrophy to meso-eutrophy due to a large increase in phosphorus loading. The change in the trophic state was paralleled by marked changes in the biotic structure and productivity. Reactive phosphorus concentration in the lake varied from about 10 micrograms/L in the early 60's up to about 35 micrograms/L in the middle of the 70's, followed by a decline down to 18 micrograms/L, essentially due to treatment plant implementation and phosphorus reduction in detergents. Primary production showed a three-fold increase in the 60's. Some aspects of the long-term evolution of plankton communities in Lake Maggiore as related to the observed environmental changes are considered. In 1955 the community was characterized by low biomass and high diversity; moreover, the species composition has changed with time. There are progressive and noticeable changes in zooplankton from the beginning of the century to 1985. Lake Maggiore is often considered to be a food limited system. Yet, the very successful introduction in 1950 of a new planktophagous fish, with the subsequent disappearance of shad and the decline of the formerly present whitefish, affected the previous relationships between zooplankton community structure and population dynamics. The recent changes in plankton structure and biomass seem to indicate the existence in Lake Maggiore of a resilience in the biotic response to phosphorus reduction. (Davis-PTT)
W89-05166

LAKES. 9. MODELS: MODELING WATER QUALITY IN RESERVOIR TAILWATERS,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
M. J. Zimmerman.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IVTLAP, Vol. 23, No. 2, p 772-777, August 1988. 3 fig, 2 tab, 2 ref.

Descriptors: *Dam effects, *Hydrologic models, *Reservoirs, *Water quality, *Tailwaters, Rivers, Hydropower, Navigation, Flood control, Recreation, Simulation studies, Chattahoochee River, Water temperature, Hydrographs, Regulated rivers.

Flows of most major river systems of the world have been modified to meet development needs. Multi-purpose projects commonly serve a wide variety of societal requirements, including flood control, navigation, hydropower generation, water supply, fish and wildlife, and general recreation. Modeling studies quantitatively estimate potential impacts of new projects or operational modifications of existing ones prior to their implementation. Simulating water quality in the tailwater environment requires interaction among many distinct subject areas including: limnological data, hydrological data, and biogeochemical data. Primary concerns in water quality modeling center on temperature and dissolved oxygen concentrations. Seasonal differences in various water quality parameters must be taken into consideration when developing data for simulations. Release rates, which may change several times per day in response to hydropower generation needs, will also affect downstream water quality. Extensive databases have been generated from periodic monitoring programs, but they may be inadequate to provide the fine detail required of a particular study. For long reaches of large rivers, frequent data collection would not only be impractical but unnecessary as the degree of resolution obtainable cannot be the same as in smaller systems where precise standards must be met at specific locations. For such cases, average values or ranges of values may suffice. Water quality modeling of tailwaters, regulated rivers and streams has its greatest value in determining relative impacts of various operational alternatives. A modeling study that examined the effect of the addition of a reregulation dam on water quality along an 80 km reach of the Chattahoochee River near Atlanta is presented as a case study. (Davis-PTT)
W89-05170

REGRESSION EQUATIONS FOR LAKE MANAGEMENT: HOW FAR DO THEY GO,
Senter for Industriforskning, Oslo (Norway).
K. L. Seip, and H. Ibrekk.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IVTLAP, Vol. 23, No. 2, p 778-785, August 1988. 3 fig, 1 tab, 29 ref.

Descriptors: *Water quality management, *Lake restoration, *Limnology, *Model studies, *Planning, Norway, Ecological models, Lake management, Secchi disks, Algae, Recreation, Purification costs, Phosphorus removal, Fish management, Hydroelectric plants, Dams.

Water resource management requires conceptual or numerical ecological models relating water quality parameters to alternative management options or scenarios. In Norway, there are about 440,000 lakes covering an area of 17,000 sq km. To assist in management of these lakes, a data system is being developed for calculating ecological and socio-economic consequences of lake eutrophication. The system is based upon regression equations for calculating ecological consequences and expert system techniques for choosing the correct equations and assessing the results. This approach was applied to Norwegian lakes and the results were compared to observations. The most important lake management options in Norway are phosphorus abatement measures, water through-flow regulation (via hydroelectric power dams) and fish management. The ecological response parameters were Secchi disk depth, percentage blue-green algae, fish biomass and macrophyte cover. As socio-economic indicators, recreation, drinking water purification costs and fish utility were chosen. Regression equations are given for algal biomass vs. total phosphorus; aquatic macrophytes vs. lake area; fish vs. phytoplankton biomass; fish utility vs. fish yield and species composition; Secchi disk depth vs. algal biomass; recreational value as a function of Secchi disk depth and blue-green algae; drinking water treatment cost vs. phytoplankton biomass and blue-green algae. Available regression equations relating nine lake response parameters to selected management variables tended to give higher estimates than actually observed for low values of the variables and lower estimates for eutrophic waters. (Davis-PTT)
W89-05171

APPLICATION OF THE ECOLOGICAL MODEL FINNECO TO LAKE GJERSJOEN,
Norsk Inst. for Vannforskning, Oslo.
T. Tjomsland, and B. A. Faafeng.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IVTLAP, Vol. 23, No. 2, p 786-789, August 1988. 2 fig, 6 ref.

Descriptors: *Lake restoration, *Norway, *Limnology, *Water quality management, *Model stud-

ies, FINNECO, Eutrophic lakes, Lake Gjersjoen, Oxygen content, Nitrogen, Phosphorus, Phytoplankton, Limiting nutrients.

A reasonable management plan for eutrophied lakes necessitates a quantitative understanding of the dominating ecological processes. A numerical model FINNECO was developed by the National Board of Waters in Finland. The amount of phytoplankton is a function of the temperature dependent processes of growth, respiration, mortality and sedimentation, and grazing by zooplankton. The model was tested against observations from Lake Gjersjoen in SE Norway during the ice free seasons in 1971, 1980, and 1983. The model shows the increase in the oxygen content near the surface and reduced values at the thermocline. The simulated oxygen values increased slightly downwards from the thermocline. This agreed with observations in 1983. The model did not successfully simulate the oxygen deficit in the bottom layer for 1971. The simulated nitrogen and phosphorus contents coincided relatively well with the observed values. The most common phytoplankton groups were blue-green algae and diatoms. The model simulated the main changes in abundance of the most important phytoplankton groups. Phosphorus was the limiting nutrient. The spring bloom was simulated a little too early but at almost the correct magnitude in spite of considerable differences in available phosphorus and input values of the phytoplankton at the start of the simulated period. The model did not adequately simulate the decrease of blue-green algae biomass in the middle of the summer. The model has been used rather successfully as a tool to help manage Lake Gjersjoen. There is a need for better handling of anaerobic conditions and the effects of wind. (Davis-PTT)
W89-05172

PHYTOPLANKTON MODELLING BY MEANS OF OPTIMIZATION: A 10-YEAR EXPERIENCE WITH BLOOM II,
Waterloopkundig Lab. te Delft (Netherlands).
F. J. Los, and J. J. Brinkman.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IVTLAP, Vol. 23, No. 2, p 790-795, August 1988, 4 fig, 6 ref.

Descriptors: *Water quality management, *Limnology, *Model studies, *Eutrophic lakes, The Netherlands, Chlorophyll a, Rhine River, Phytoplankton, BLOOM II, Algae, Biomass.

The Netherlands have suffered heavily from eutrophication problems at least since the beginning of the twentieth century because about two thirds of the annual freshwater supply is provided by the Rhine River and sediments contribute considerably to the annual nutrients loadings of most Dutch lakes. The first models used to support the decision-making process for reacting to this eutrophication process were the OECD models. The computed chlorophyll levels however, were far below the observations. The next step was to copy deterministic eutrophication models, most of which were originally developed in the United States for the Great Lakes. Application of these models was not successful either; again, the computed chlorophyll levels were too low. A different modelling approach was started approximately ten years ago. A salt water model was revised and a model called BLOOM II was developed. This model uses an optimization technique called linear programming to compute the maximum total biomass concentration of several phytoplankton species at equilibrium in a certain time period consistent with the environmental conditions. To extend the scope of BLOOM II, it was coupled with the chemical model CHARON and to the general water quality model DELWAQ. After its initial calibration BLOOM II was applied to about 30 different lakes for between one and nine consecutive years. The model is first validated with measured nutrient data, and then phytoplankton and nutrients are validated using the integrated BLOOM II-CHARON model. The computed and measured chlorophyll levels agree very well for the two lakes that were studied (Lake Veluwe and Lake Wolderwijd). The model predicts dominance of the blue-green alga Oscillatoria agardhii in all cases, which agrees with the observation. BLOOM II is still being updated and extended. (Davis-PTT)
W89-05173

LAKE OF VIRELLES (PROV. HAINAUT, BELGIUM): MANAGEMENT OF A LAKE FOR NATURE CONSERVATION AND RECREATION,
Vrije Univ., Brussels (Belgium). Lab. voor Algemene Plantkunde en Natuurbeheer.
For primary bibliographic entry see Field 6G.
W89-05194

NEW JERSEY'S COASTAL WATER QUALITY MANAGEMENT PROJECT - METHODOLOGIES FOR THE PROTECTION OF ESTUARINE WATER QUALITY AND SHELLFISH RESOURCES,
New Jersey Dept. of Environmental Protection, Trenton. Div. of Water Resources.
K. Robinson, and G. Horzepa.
Journal of Shellfish Research JSHRDA, Vol. 7, No. 2, p 253-259, October 1988. 2 tab, 10 ref.

Descriptors: *Management planning, *Coastal zone management, *Nonpoint pollution sources, *Water quality control, *Water pollution control, *Water quality management, *Estuaries, *New Jersey, *Shellfish, Regional planning, Management planning, Coastal waters.

Degradation of estuarine water quality is the result of increased residential and commercial development throughout New Jersey's coastal region. Nonpoint sources and stormwater runoff are the primary pollutant sources from this development, as point sources have generally been eliminated. This has resulted in the restriction of important water uses, such as shellfish harvesting and primary contact recreation, in waterways that were formally of great value. New Jersey's Department of Environmental Protection realized that existing water quality management programs were not adequate from the standpoint of controlling runoff and other nonpoint sources. The Department has developed a water quality and shellfish resource assessment methodology that defines past and current conditions of specific estuarine waterways. The results are used to determine the degree and type of water quality management actions necessary for protection of water quality and designated uses. Management programs are coordinated through State, county and municipal planning activities. The assessment methodology can be applied to a variety of water uses and waterbody types. (Author's abstract)
W89-05240

TIDAL SALT MARSH RESTORATION,
North Carolina State Univ. at Raleigh. Dept. of Soil Science.
S. W. Broome, E. D. Seneca, and W. W. Woodhouse.
Aquatic Botany AQBODS, Vol. 32, No. 1-2, p 1-22, October 1988. 7 fig, 1 tab, 23 ref.

Descriptors: *Wetland restoration, *Tidal marshes, *Salt marshes, *Marsh management, *Revegetation, Coastal marshes, Vegetation establishment, Angiosperms, Ecosystems, Reviews, Marsh plants.

Coastal salt marshes occur in the intertidal zone of moderate to low energy shorelines along estuaries, bays, and tidal rivers. They have ecological value in primary production, nutrient cycling, as habitat for fish, birds, and other wildlife and in stabilizing shorelines. Disturbance by development activities has resulted in the destruction or degradation of many marshes. Awareness of this loss by scientists and the public has led to an interest in restoration or creation of marshes to enhance estuarine ecosystems. Recovery of marshes after human perturbation such as dredging, discharges of wastes and spillage of petroleum products or other toxic chemicals is often slow under natural conditions and can be accelerated by replanting vegetation. The basic techniques and procedures have been worked out for the propagation of several marsh angiosperms. Factors which affect successful revegetation include elevation of the site in relation to tidal regime, slope, exposure to wave action, soil chemical and physical characteristics, nutrient supply, salinity and availability of viable propagules of the appropriate plant species. Marsh restoration technology has been applied at a variety of locations to vegetate intertidal dredged material disposal sites, stabilize shorelines, mitigate damage to natural marshes and to revegetate one marsh destroyed by an oil spill. Contractual services for marsh establishment are now available in some regions. Further research is needed to determine the success of marsh restoration and creation in terms of ecological function, including the faunal component. (Author's abstract)
W89-05255

PHOSPHORUS LOSSES FROM CROPLAND AS AFFECTED BY TILLAGE SYSTEM AND FERTILIZER APPLICATION METHOD,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Agricultural Engineering.
S. Mostaghimi, J. M. Flagg, T. A. Dillaha, and V. O. Shanholtz.
Water Resources Bulletin WARBAQ, Vol. 24, No. 4, p 735-742, August 1988. 4 fig, 6 tab, 17 ref.

Descriptors: *Water pollution sources, *Water pollution prevention *Nonpoint pollution sources, *Phosphorus, *Agricultural hydrology, *Rainfall impact, *Cultivated lands, Soil chemistry, Simulation, Fertilizers, Comparison studies, Injection, Agricultural engineering.

A rainfall simulator was used to study the effectiveness of no-till and fertilizer application method on reducing phosphorus (P) losses from agricultural lands. Simulated rainfall was applied to 12 experimental field plots, each 0.01 ha in size. The plots were divided into no-till and conventional tillage systems. Two fertilizer application methods, subsurface injection and surface application, were investigated for the two tillage systems. Phosphorus fertilizer was applied at a rate of 46 kg/ha, 24 to 48 hours before the start of rain simulation. Water samples were collected from the base of each plot and analyzed for sediment and P content. No-till was found to be very effective in reducing runoff and sediment losses. No-till reduced sediment loss and total runoff volume by 92 and 67%, respectively. Subsurface injection of fertilizer, as compared to surface application, reduced PO4 losses by 39% for no-till and by 35% for conventional tillage. The effect of the tillage system on PO4 losses was not significant. Reductions in total P (P sub T) losses due to no-till compared to the conventional tillage system were 89 and 91% for surface application and subsurface injection methods, respectively. Averaged across all fertilizer treatments, an equivalent of 0.9 and 8.9% of the P applied to the plots were lost from the no-till and conventional tillage plots, respectively. (Author's abstract)
W89-05263

CALCIUM EFFECTS ON CADMIUM UPTAKE, REDISTRIBUTION, AND ELIMINATION IN MINNOWS, PHOXINUS PHOXINUS, ACCLIMATED TO DIFFERENT CALCIUM CONCENTRATIONS,
Uppsala Univ. (Sweden). Dept. of Zoology.
For primary bibliographic entry see Field 5B.
W89-05313

OVERVIEW OF ENVIRONMENTAL SANITATION IN RURAL NIGERIA,
Nigerian Inst. of Social and Economic Research, Ibadan.
F. Olokesusi.
Environmental Education and Information, Vol. 7, No. 2, p 62-76, April-June 1988. 8 tab, 8 ref.

Descriptors: *Regional development, *Rural areas, *Water quality, *Nigeria, *Water management, *Water quality control, *Social aspects, *Sanitation, Water supply, Water supply development, Community development.

A review of the water aspects of rural environmental sanitation includes both sanitary conditions

and causal factors. The socio-economic impacts of these conditions on rural development within the context of national development are outlined, and available water technologies, levels of service and standards that have promoted effective sanitary conditions in the rural communities in Nigeria are identified and assessed. The most significant factors responsible for poor access to water and sanitary facilities, as well as the socio-economic impacts of deprivation, are poverty, political deprivation, lack of physical planning and cultural practices. It is concluded that good health is possible in the simplest homes, when families know about basic health needs and how to protect themselves against other causes of disease. Amenities in rural homes and communities can be improved a little at cost, while small changes in behavior can bring greater benefits. For example, hand-washing after defecation and before handling food and feeding children has a marked effect on the incidence of diarrhea. The success of these recommendations however, lies in the right political atmosphere, purposeful rural health education and training of local health staff, and a proper economic framework. (Friedmann-PTT)
W89-05337

ANTIFOULING PAINTS: USE ON BOATS IN SAN DIEGO BAY AND A WAY TO MINIMIZE ADVERSE IMPACTS,
Scripps Institution of Oceanography, La Jolla, CA. Center for Coastal Studies.
For primary bibliographic entry see Field 5B.
W89-05341

EVALUATION OF ALTERNATIVE OIL SPILL CLEANUP TECHNIQUES IN A SPARTINA ALTERNIFLORA SALT MARSH,
Texas A and M Univ. at Galveston. Dept. of Marine Biology.
R. W. Kiesling, S. K. Alexander, and J. W. Webb.
Environmental Pollution ENPOEK, Vol. 55, No. 3, p 221-238, 1988. 1 fig, 4 tab, 43 ref.

Descriptors: *Oil spills, *Spartina, *Salt marshes, *Cleanup, Marshes, Simulation, Oil, Water pollution, Flushing.

Three oil spill situations which cause long-term impact were simulated in 1-sq m salt marsh plots to evaluate the effectiveness of alternative cleanup techniques at removing oil and reducing damage to Spartina alterniflora. Cleanup techniques, implemented 18-24 hrs after oiling, were not effective at removing oil after sediment penetration. When oil remained on the sediment surface, flushing techniques were most effective at removal, reducing levels of added oil by 73 to 83%. The addition of dispersant to the flushing stream only slightly enhanced oil removal. Clipping of vegetation followed by sorbent pad application to sediment was moderately effective, reducing added oil by 36 to 44%. In contrast to flushing and clipping, burning increased the amount of oil in sediment by 27 to 72%. Although flushing and clipping were effective at oil removal, neither technique reduced initial damage to plants or enhanced long-term recovery. While flushed plots sustained no additional plant damage due to cleanup, clipped and burned plots sustained additional initial plant damage. It is concluded that first consideration should be given to natural tidal flushing as the means to remove oil, especially in salt marshes subject to ample tidal inundation. (Author's abstract)
W89-05357

IMPACT OF PHOSPHORUS REDUCTION VIA METALIMNETIC ALUM INJECTION IN BULLHEAD LAKE, WISCONSIN,
Geological Survey, Madison, WI. Water Resources Div.
R. P. Narf.
Wisconsin Department of Natural Resources Technical Bulletin No. 153, 1985. 25p, 16 fig, 9 tab, 58 ref.

Descriptors: *Bullhead Lake, *Alum, *Phosphorus removal, *Water quality control, *Lake rehabilitation, Aluminum sulfate, Ecological effects, Wisconsin, Plankton, Benthic environment, Algae, Diatoms.

Bullhead Lake, a 27 ha hard water dimictic lake with a maximum depth of 10.5 m, was treated with aluminum sulfate (alum) via metalimnetic injection on 23 August 1978. The treatment was designed to evaluate the use of metalimnetic alum injection for phosphorus control and to determine the effect of alum on plankton and benthos. The project began in June 1975 and continued through December 1982. Nutrient content, planktonic biota, and benthic community composition and response were determined. The alum significantly reduced internal phosphorus recycling. Summer epilimnetic total phosphorus (TP) was reduced from a 1978 pretreatment mean concentration of 41 micrograms TPP/L to 16 micrograms TP/L in 1979. Mean soluble reactive phosphorus (SRP) levels were reduced from 8 micrograms to < 4 micrograms SRP/L in the same period. Post-treatment phosphorus levels remained low to the end of the study period. The reduction in phosphorus had a direct effect on the biota. Green algae, flagellates, and diatoms increased and blue-green algae decreased. Generally, the zooplankton increased in density and diversity; the rotifers increased dramatically. The benthic community also increased in numbers and taxa. The increase in the biotic community indicates that the aluminum hydroxide flocculent had little or no toxic effect upon these organisms. Metalimnetic injection is a practical application method. Injecting the alum below the epilimnion reduces possible toxic effects and places the alum on the anoxic sediment which is the primary source of recycled phosphorus. (Author's abstract)
W89-05393

GUIDANCE FOR APPLICANTS FOR STATE WELLHEAD PROTECTION PROGRAM ASSISTANCE FUNDS UNDER THE SAFE DRINKING WATER ACT.
Environmental Protection Agency, Washington, DC. Office of Ground-Water Protection.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-111422. Price codes: A04 in paper copy, A01 in microfiche. June 1987. 53p, 10 exhibits, 3 append.

Descriptors: *Standards, *Drinking water, *Groundwater protection, *Water quality control, Safe Drinking Water Act, Regulations, Water supply, Legislation, Wells.

The 1986 Amendments to the Safe Drinking Water Act (SDWA) establish a new Wellhead Protection (WHP) Program to protect groundwaters that supply wells and wellfields contributing drinking water to public water supply systems. This Guidance outlines procedural and technical information that eligible applicants need to apply for Federal grant funds to develop and implement these WHP Programs. The Program offers an innovative approach to groundwater protection. Unlike most other environmental programs, the WHP Program focuses on the entire resource requiring protection, rather than on a limited set of sources or contaminants. The WHP Program, furthermore, focuses on a very important subset of groundwater resources; that is, specific areas that supply wells or wellfields withdrawing drinking water for public systems. This focus on public water systems will protect approximately 90% of the total amount of groundwater used for drinking in the United States. The management of contamination risks to these wells through the WHP Program, therefore, provides the basis for significant gains in human health protection in a focused, effective manner. (Lantz-PTT)
W89-05401

PROGRAM FOR MONITORING THE CHEMICAL QUALITY OF GROUND WATER IN UTAH--SUMMARY OF DATA COLLECTED THROUGH 1984,
Geological Survey, Salt Lake City, UT. Water Resources Div.
For primary bibliographic entry see Field 7A.
W89-05413

HYDROLOGY AND WATER QUALITY OF DELAVAN LAKE IN SOUTHEASTERN WISCONSIN,
Geological Survey, Madison, WI. Water Resources Div.
For primary bibliographic entry see Field 5B.
W89-05424

OIL IN FRESHWATER: CHEMISTRY, BIOLOGY, COUNTERMEASURE TECHNOLOGY.
For primary bibliographic entry see Field 5C.
W89-05430

IMMISCIBLE TRANSPORT OF HYDROCARBONS INFILTRATING IN UNCONFINED AQUIFERS,
Eidgenoessische Technische Hochschule, Zurich (Switzerland). Inst. fuer Hydromechanik und Wasserwirtschaft.
For primary bibliographic entry see Field 5B.
W89-05443

INDUCED SOIL VENTING FOR RECOVERY/RESTORATION OF GASOLINE HYDROCARBONS IN THE VADOSE ZONE,
Connecticut Univ., Storrs. Dept. of Civil Engineering.
G. E. Hoag, C. J. Bruell, and M. C. Marley.
IN: Oil in Freshwater: Chemistry, Biology, Countermeasure Technology. Pergamon Press, New York, NY, 1987. Edited by John H. Vandermeulen and Steve E. Hrudey. p 176-194, 4 fig, 6 tab, 23 ref, append.

Descriptors: *Hydrocarbons, *Gasoline, *Cleanup operations, *Evaporation, Permeability, Vadose water, Gas chromatography, Aromatic compounds, Soil water, Computer models, Leakage, Theoretical analysis.

Induced soil venting can be a rapid, efficient method for the removal of insular and pellicular gasoline trapped in soils following a spill or leak. Evaporation rates of > 50 gasoline hydrocarbon components were measured in laboratory soil column experiments. The effects of soil density, moisture content, particle size, and induced air flow rate were determined. Residual soil saturation by gasoline and soil permeability to air and water were evaluated over the range of soil conditions. Gasoline recovery from soils by soil venting exceeded 99% in all experiments as determined by GC, GC/MS and bulk weight analyses. Sequential volatilization of gasoline components was related to compound vapor pressure and mole fraction variations in the solvent phase with respect to time. Vapor phase equilibrium saturation of the air, used for the venting, was apparent. The study suggests that induced soil venting would be an effective and predictable remedial action at hydrocarbon spill sites, particularly through the reduction of the overall time of possible contaminant input. This is achieved by the removal of hydrocarbons from the residually saturated soil in contact with the fluctuating water table and percolating rainwater. Controlled venting of the hydrocarbon contaminated soil will reduce the changes of fires and explosions by directing the vapors to a chosen location. (See also W89-04530) (Geiger-PTT)
W89-05444

EFFECT OF OIL DISPERSANTS ON MICROBIALLY-MEDIATED PROCESSES IN FRESHWATER SYSTEMS,
Alberta Univ., Edmonton. Dept. of Microbiology.
For primary bibliographic entry see Field 5C.
W89-05448

NATURAL DETOXIFICATION AND COLONIZATION OF OIL SANDS TAILINGS WATER IN EXPERIMENTAL PITS,
Syncrude Canada Ltd., Edmonton (Alberta).
For primary bibliographic entry see Field 5B.
W89-05455

TECHNOLOGY FOR REMOVAL OF HYDROCARBONS FROM SURFACE AND GROUNDWATER SOURCES,
Engineering-Science, Inc., Austin, TX.

For primary bibliographic entry see Field 5D.
W89-05458

LABORATORY EXPERIMENTS ON OIL SPILL PROTECTION OF A WATER INTAKE,
Waterloopkundig Lab. te Delft (Netherlands).
For primary bibliographic entry see Field 5F.
W89-05461

OIL AND POLYNUCLEAR AROMATIC HYDROCARBON CONTAMINATION OF ROAD RUNOFF - A COMPARISON OF TREATMENT PROCEDURES,
Imperial Coll. of Science and Technology, London (England). Dept. of Civil Engineering.
R. Perry, and A. E. McIntyre.
IN: Oil in Freshwater: Chemistry, Biology, Countermeasure Technology. Pergamon Press, New York, NY, 1987. Edited by John H. Vandermeulen and Steve E. Hrudey. p 474-484, 4 fig, 7 tab, 18 ref.

Descriptors: *Water pollution treatment, *Aromatic compounds, *Oil pollution, *Surface runoff, *Water pollution prevention, Highway effects, Hydrocarbons, Water pollution sources, Sedimentation, Drains, Water quality control, Groundwater pollution.

The sources and occurrence of oil and polynuclear aromatic hydrocarbons (PAH) in road runoff are considered in the light of possible treatment procedures. An evaluation has been conducted of three treatment processes for a heavily travelled motorway: a sedimentation tank, a lagoon system and a french drain. The treatment efficiency of each process has been assessed with respect to solids, oil and PAH. The sedimentation tank was found to be least efficient, while the french drain was marginally more effective than the lagoon in the removal of solids, oil and PAH. Oil and PAH removal by the french drain treatment process would be expected to be enhanced over the sedimentation tank and lagoon system, because the drain effectively functions as a filter system, perhaps with some similarity to a conventional percolating filter. The french drain requires less land area than the other two processes and could possibly operate without maintenance for a period of up to nine years. (See also W89-04530) (Author's abstract)
W89-05463

INFLUENCE OF UNDERGROUND OPENINGS ON GASOLINE SPILL MIGRATION AND RECOVERY IN DOWNTOWN EDMONTON,
O'Connor (M.J.) and Associates Ltd., Calgary (Alberta).
For primary bibliographic entry see Field 5B.
W89-05464

VARIABLE DENSITY FLUID FLOW IN THE BRACKISH TRANSITION ZONE BETWEEN FRESH AND SALINE GROUNDWATER,
Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands).
For primary bibliographic entry see Field 2F.
W89-05470

INCORPORATING ASSURANCE INTO GROUNDWATER QUALITY MANAGEMENT MODELS,
Geological Survey, Menlo Park, CA.
S. M. Gorelick.
IN: Groundwater Flow and Quality Modelling. D. Reidel Publishing Co., Boston. 1988. p 135-150, 39 ref.

Descriptors: *Quality assurance, *Water quality management, *Groundwater quality, *Groundwater management, *Model studies, Aquifers, Flow velocity, Permeability coefficient, Water quality control, Hydrologic models.

Recent efforts in aquifer management modelling have tried to account for uncertainty in predicted groundwater flow velocities and concentrations. Although there are many origins of model prediction uncertainty, model misspecification represents a significant one. Two types of model misspecification have been addressed. First is inadequate description of spatial variability of hydraulic conductivities. The latest approach has been to develop robust aquifer management plans that remain optimal in the presence of unknown spatial variability. The second type of model misspecification that has been looked at is model parameter uncertainty. For this problem, parameter estimation has been united with nonlinear stochastic optimization. Plans to control water quality degradation are developed that account for both flow and transport parameter uncertainty. The management model assures specified local water quality standards will be met at a specified reliability level. A brief survey of older literature shows that most studies were limited because they treated groundwater quality management models as linear systems. In the past five years problems have been formulated and solved using nonlinear systems theory. Furthermore, studies have begun to incorporate model uncertainty. These efforts, which attempt to account for both nonlinearity and model uncertainty, are critically analyzed in this review. (See also W89-05465) (Author's abstract)
W89-05473

LOCAL GROUNDWATER PROTECTION,
Illinois Univ. at Chicago Circle. School of Urban Planning and Policy.
M. Jaffe, and F. DiNovo.
American Planning Association, Washington, DC. 1987. 262p.

Descriptors: *Groundwater management, *Water pollution prevention, *Water quality control, *Groundwater pollution, Management planning, Drinking water, Groundwater quality, Policy making, Gasoline, Leakage, Wells, Regulations, Michigan.

Atlanta, Michigan's groundwater--providing drinking water to the hamlet's 500 residents--is contaminated with benzene, toluene, xylene, dichloroethanes and trichloroethanes, and phenols. The groundwater pollution was traced to leaking underground gasoline storage tanks at local automobile service stations. After the leakage was discovered, the tanks were repaired. But the hamlet's groundwater remained polluted, requiring the closure of many wells. Like most communities in America, Atlanta simply took its drinking water supply for granted and did not recognize the vulnerability of its groundwater resources. Planners must be involved in groundwater protection because of the relative permanence and irreversibility of groundwater contamination, compared to surface water pollution. By surveying a good cross-section of the existing and proposed groundwater protection programs that have been put into place by local governments, this book is intended to serve as a sourcebook for the future development of such programs. These local examples can suggest many useful strategies and techniques that can be considered by local officials and planners concerned about groundwater protection. This process is mirrored in the structure of this book. The first four chapters provide the background information that has to be collected and assessed prior to developing a local planning and management program; later chapters build on this basic information and examine the studies, policies, and regulations that can be considered to address various groundwater threats facing a community. (Lantz-PTT)
W89-05508

CLEAN WATER ACT: UPDATE,
Smith and Schnacke, Dayton, OH.
R. S. Frye, and, J. N. Hanson, and H. I. E. Bjornson.
Executive Enterprises Publications Co., Inc., New York. 1987. 198p.

Descriptors: *Water pollution prevention, *Clean Water Act, *Legislation, *Water pollution control, Regulation, Industrial wastewater, Municipal wastewater, Permits.

The purpose of this book is (1) to acquaint the reader with major changes in the federal Clean Water Act which were enacted in 1987 and with new or revised regulations and court decisions of the past three years, which will have a significant impact on wastewater dischargers; and (2) to supplement and update a previous book, 'Clean Water Act Permit Guidance Manual'. That book provides a comprehensive discussion of the rules which apply to industrial or municipal dischargers, along with a discussion of issues and tactics in NPDES permit negotiations. (Lantz-PTT)
W89-05509

PRELIMINARY ANALYSIS OF NUTRIENT MONITORING DATA FOR THE SUSQUEHANNA RIVER AND SELECTED TRIBUTARIES: JANUARY 1, 1985 - DECEMBER 31, 1987,
Susquehanna River Basin Commission, Harrisburg, PA.
A. N. Ott, C. S. Takita, R. E. Edwards, and S. W. Bollinger.
Publication No. 120, April 1988. 21p, 5 tab, append.

Descriptors: *Data collections, *Monitoring, *Susquehanna River, *Tributaries, *Water quality control, *Nutrients, *Data interpretation, Nonpoint pollution sources, Data acquisition, Chesapeake Bay, Interstate commissions, Water pollution treatment, Regional planning, Model studies.

The 1987 Chesapeake Bay Agreement states that 'the improvement and maintenance of water quality is the single most critical element in the overall restoration and protection of the bay.' Improvement in water quality includes 'the reduction of nutrients from both point and nonpoint sources.' Agreement was reached to set a goal for achieving a 40% reduction in nutrients entering the bay system by the year 2000. Data that is useful in developing a plan to achieve that goal has been and is being collected for the Chesapeake Bay Program by a joint program directed by the Susquehanna River Basin Commission. The objective of this joint Susquehanna River Basin Commission program is to collect, collate, analyze and disseminate nutrient data for the Susquehanna River and selected tributaries. This program establishes a sound database which can be used to effectively plan and implement both immediate and long-range nutrient reduction efforts and support modeling activities. These data were also used to estimate the nutrient loads for this report. (Lantz-PTT)
W89-05511

CASE HISTORIES OF COASTAL AND MARINE MINES,
Victoria Univ. (British Columbia). Dept. of Biology.
For primary bibliographic entry see Field 5C.
W89-05559

GEOCHEMISTRY OF PRIORITY POLLUTANTS IN ANOXIC SLUDGES: CADMIUM, ARSENIC, METHYL MERCURY, AND CHLORINATED ORGANICS,
Technische Univ. Hamburg-Harburg (Germany, F.R.). Arbeitsbereich Umweltschutztechnik.
For primary bibliographic entry see Field 5B.
W89-05563

ECOLOGICAL ENGINEERING: BIOLOGICAL AND GEOCHEMICAL ASPECTS PHASE I EXPERIMENTS,
Boojum Research Ltd., Toronto (Ontario).
M. Kalin, and R. O. van Everdingen.
IN: Environmental Management of Solid Waste: Dredged Material and Mine Tailings. Springer-Verlag, New York, NY. 1988. p 114-128, 1 tab, 3 fig, 21 ref.

Descriptors: *Water pollution control, *Environmental engineering, *Water quality control, *Acid mine drainage, *Mine wastes, *Biological treatment, *Geochemistry, Mine drainage, Mosses, Oxidation, Algae, Wetlands, Vegetation establishment, Sulfates, Freezing.

Ecological engineering research develops methods which facilitate the establishment of vegetation

cover types to serve as self-maintaining acid drainage treatment systems. On dry surface areas with sparse vegetation cover, terrestrial moss cover curtails precipitation infiltration while the vascular plant cover investigated had no amelioration effect on the underlaying tailings. Wetlands established in waterlogged, submerged sections and seepages reduce water infiltration and acid generation, as well as removing metals. The precipitates in settling and polishing ponds from treatment plant operation have to be maintained in an alkaline state. Some species of Charophytes tested appear to be suitable for these conditions. Relative abundance values for O18 in sulfate produced at one tailings site indicate that a major proportion of the sulfate oxygen is derived from water molecules rather than from molecular oxygen, suggesting that oxidation proceeds partly under anaerobic, water saturated conditions. It is likely that the oxidation of sulfides in the tailings can be stopped only if the tailings are permanently submerged in completely stagnant water. Data from freezing gauges and a thermistor cable installed in the tailings indicate that frost penetration in the tailings is minimal, suggesting the rate of sulfide oxidation may not be reduced significantly during the winter. (See also W89-05568) (Author's Abstract)
W89-05575

REHABILITATION MEASURES AT THE RUM JUNGLE MINE SITE,
Australian Nuclear Science and Technology Organisation, Sutherland. Environmental Science Div.
J. R. Harries, and A. I. M. Ritchie.
IN: Environmental Management of Solid Waste: Dredged Material and Mine Tailings. Springer-Verlag, New York, NY. 1988. p 131-151, 5 tab, 7 fig, 44 ref.

Descriptors: *Water quality management, *Water pollution prevention, *Mine wastes, *Acid mine drainage, *Land reclamation, *Rehabilitation, Sealants, Leachates, Revegetation, Infiltration, Australia, Trace metals.

Rum Jungle Mine Site is about 80km south of Darwin in the tropical northern Territory of Australia where there is a well-defined wet season when much of the rain falls as localized thunderstorms. After the mine closed it was apparent that aquatic flora and fauna in the stream below the mine site were adversely affected because of the high trace metal content, predominantly Cu, Mn, and Zn, in the water. The rehabilitation strategy was to: (1) Cover the overburden dumps with a seal to reduce the ingress of water; (2) Collect the tailings and cover them with enough material to reduce radon emanation; (3) Remove the copper heap leach pile and dispose of the material above the water table in a location with minimal water ingress; (4) Raise the pH in the water in the open cuts and reduce the trace metal concentration to a limited recreational standard; (5) Clean up and revegetate other areas. Tentative conclusions indicate the cover has proved effective in reducing the infiltration rate of water from about 50-60% of incident rain to about 3%. However, although the cover was initially very effective in reducing the ingress of air, it has proved less effective after exposure to its first dry season. After two years the oxidation rates within the pyritic waste material remain lower than pre-rehabilitation levels. (See also W89-05568) (White-Reimer-PTT)
W89-05576

MINE TAILINGS RECLAMATION: INCO LIMITED'S EXPERIENCE WITH THE RECLAIMING OF SULPHIDE TAILINGS IN THE SUDBURY AREA, ONTARIO, CANADA,
T. H. Peters.
IN: Environmental Management of Solid Waste: Dredged Material and Mine Tailings. Springer-Verlag, New York, NY. 1988. p 152-165, 1 tab, 18 ref.

Descriptors: *Ontario, *Water pollution prevention, *Mine wastes, *Acid mine drainage, *Land reclamation, *Sulfides, Fate of pollutants, Acidic soils, Rehabilitation, Revegetation, Metals, Trace elements, Sudbury Area, Canada, Seepage.

Although tailored to the specific conditions of the Sudbury area, the methods used were similar to those in other areas and included: (1) Establishment of initial plant communities using available species that are tolerant of drought, low soil pH, poor soil texture, the lack of organic materials and nutrients, and other factors characteristic of metal-extracted tailings. (2) Modification of the local plant microclimate to benefit plant establishment. The development of a thick root structure, along with the accumulation of decaying vegetation on the surface, sets up an oxygen-intercept layer, which reduces the amount of oxygen penetrating into the sulfide tailings and thus reduces the rate of acid formation which in turn reduces the residual trace elements in the seepage water. (3) Establishment of soil invertebrate and microbial communities to decompose naturally accumulating organic matter and to assist in the building of a soil. (4) Establishment of essential nutrient cycles. The physical ability of soil to retain moisture and nutrients is essentially a function of particle size. (5) Establishment of a vegetative habitat suitable for wildlife colonization. (6) By manipulating species competition, the establishment of climax plant communities for the area. (See also W89-05568) (White-Reimer-PTT)
W89-05577

DEVELOPMENT OF A REVEGETATION PROGRAMME FOR COPPER AND SULPHIDE-BEARING MINE WASTES IN THE HUMID TROPICS,
Bougainville Copper Ltd., Panguna (Papua New Guinea).
I. M. Archer, N. A. Marshman, and W. Salomons.
IN: Environmental Management of Solid Waste: Dredged Material and Mine Tailings. Springer-Verlag, New York, NY. 1988. p 166-184, 5 tab, 3 fig, 31 ref.

Descriptors: *Copper, *Revegetation, *Land reclamation, *Sulfides, *Cleanup, *Tropical regions, *Mine wastes, *Revegetation, *Humid areas, Acid mine drainage, Fate of pollutants, Acidic soils, Cost analysis, Species composition, Project planning, Legumes, Reclamation, Nutrients, Succession.

The development of a successful and cost-effective revegetation program has a number of stages. First, it is necessary to have an objective for the program. Site-specific research is then advisable to define potential limitations to successful plant establishment and growth. This needs to be followed by trials to demonstrate practical methods to overcome these limitations and finally revegetated areas need to be monitored so that the techniques used are assessed for their suitability in achieving the original objective. The development of a cost-effective method to revegetate areas covered with mine wastes is described. The physical, chemical and biological nature of the waste material was studied and the program has progressed from the initial setting of objects through research, trial of methodology, implementation and appraisal stages. The species chosen for revegetation are tolerant of acid soils with low available phosphorus. Herbaceous legume species comprise the major component of the seed mix, grass species a large component and shrub and tree species including inoculated legumes are also included. Some amelioration of the waste material is recognized as essential with the main emphasis being placed on pH correction and application of P fertilizer. Monitoring of the program indicates soil pH has fallen since the initial liming, but the vegetation has remained vigorous and does not exhibit nutrient deficiency symptoms. Some changes in species composition has occurred with the initially dominant legumes and grasses shaded out in about six months by the shrubs which in turn were replaced by Acacia spp. 2-3 years after establishment. At the same time species from adjacent areas begin to volunteer on the mine waste. This change in species composition is considered to be a natural and positive response by the plant community to changing habitat conditions. No active revegetation effort is carried out on waterlogged tailings deposits because such areas rapidly and naturally recolonize. (See also W89-05568) (White-Reimer-PTT)
W89-05578

BIOLOGICAL ENGINEERING OF MARINE TAILINGS BEDS,
Victoria Univ. (British Columbia). Dept. of Biology.
D. V. Ellis, and L. A. Taylor.
IN: Environmental Management of Solid Waste: Dredged Material and Mine Tailings. Springer-Verlag, New York, NY. 1988. p 185-207, 2 tab, 6 fig, 33 ref.

Descriptors: *Mine wastes, *Marine environment, *Mine drainage, *Environmental engineering, *Water pollution prevention, *Reclamation, Marine fisheries, Marine sediments, Leachates, Fish, Reefs, Productivity, Toxicity, Fate of pollutants.

In some cases fisheries continue at sites of marine tailings deposition; however, placement of the discharge system can cause fisheries losses and tailings discharged to rivers for gravity flow to the sea can block movements of fish which must complete their life cycles by river migrations. Shoreline discharges cause extreme surface turbidity, which can reduce primary biological production; shallow water discharges within the euphotic zone impact the most productive areas; and deep-water discharges restrict impacts to the less productive depths. In addition, possible upwelling effects need to be considered. An important factor underlying whether biological engineering should be allowed is whether the discharged tailing stream is toxic or not, and whether the deposited tailings will leach toxins. Procedures for fishery enhancement in both biological and engineering terms include: (1) Developing a set of artificial reefs for fisheries enhancement; (2) Shaping and fertilizing a tailings bed to enhance ground fish or shellfish fisheries; (3) Capping a tailings bed to enhance stability or to minimize leaching; and (4) Raising a fiord seabed into shallow water so that biological productivity is enhanced by primary production. (See also W89-05568) (White-Reimer-PTT)
W89-05579

RECLAMATION OF PYRITIC MINE SPOIL USING CONTAMINATED DREDGED MATERIAL,
Army Engineer Waterways Experiment Station, Vicksburg, MS.
J. W. Simmers, G. S. Wilhelm, J. M. Marquenie, R. G. Rhett, and S. H. Kay.
IN: Environmental Management of Solid Waste: Dredged Material and Mine Tailings. Springer-Verlag, New York, NY. 1988. p 208-223, 8 tab, 3 fig, 9 ref.

Descriptors: *Pyrite, *Water pollution prevention, *Spoil banks, *Dredging, *Mine wastes, *Acid mine drainage, *Land reclamation, Revegetation, Rehabilitation, Heavy metals, Acidity, Polychlorinated biphenyls, Polyaromatic hydrocarbons, Bioassay, Bioaccumulation, Solid wastes, Solid waste disposal.

The demonstration site was created amid parallel ridges of unvegetated pyritic overburden. The treated plots received a 0.9-m-thick cover of dewatered dredged material. Surface water was monitored for 1 year and soil water for 2 years. All four plots were seeded with five types of perennial grasses and one legume. The regrading of pyritic mine spoil and application of a dewatered dredged material cover halted acid runoff. The pH at the dredged material/minespoil interface remained near neutral, and vegetation was established. This demonstration project shows that a cover of dredged material can stop acid runoff while allowing speedy revegetation. The vegetation established at the site is changing in composition at a steady rate; pedogenesis is under way. Although some toxic metals, PCBs, and PAHs are present, there do not appear to be any potential routes of contaminant uptake other than the movement of Cd from leaf litter as indicated by the bioassay earthworms. The presence of low levels of contaminants in dredged material need not eliminate it from consideration for a productive use, provided appropriate bioassay monitoring procedures and management strategies are implemented. (See also W89-05568) (White-Reimer-PTT)

W89-05580

TOWARDS A LONG-TERM BALANCE BETWEEN ECONOMICS AND ENVIRONMENTAL PROTECTION,
Heidelberg Univ. (Germany, F.R.). Alfred Weber-Inst.
M. Faber, and G. Wagenhals.
IN: Environmental Management of Solid Waste: Dredged Material and Mine Tailings. Springer-Verlag, New York, NY. 1988. p 227-242, 8 fig, 20 ref.

Descriptors: *Mine wastes, *Acid mine drainage, *Mine drainage, *Environmental protection, *Model studies, Environmental quality, Multiobjective planning, Long-term planning, Entropy, Econometrics.

Based on a multisector model of the economy, fundamental qualitative equations dealing with the interrelations between mine wastes, entropy, and economic variables like mining costs or energy requirements for extraction are derived. From a microeconomic perspective the model shows that site-specific variables heavily influence cost on the microlevel. From a macroeconomic point of view, the coefficient of correlation between minimum energy requirements and actual costs may be considerable. These two results suggest that the notion of entropy presented and the corresponding notion of minimum energy requirements are not apt instruments to analyze processes on the microeconomic level (i.e. a single mine), but they may serve as powerful aids in considering macroeconomic consequences of trade-offs between economics and the environment. It is believed that the energy used in the concentrating process will eventually decline strongly and that resource prices will increase in line with increasing future energy needs even if potential technological improvements are taken into account. Estimates indicate future costs of environmental protection measures will increase considerably. To cover part of these costs, an increase in metal and mineral prices is a necessary condition. (See also W89-05568) (White-Reimer-PTT)
W89-05581

ENVIRONMENTAL MANAGEMENT OF NEW MINING OPERATIONS IN DEVELOPED COUNTRIES: THE REGIONAL COPPER-NICKEL STUDY,
Indiana Univ.-Purdue Univ. at Indianapolis.
I. M. Ritchie.
IN: Environmental Management of Solid Waste: Dredged Material and Mine Tailings. Springer-Verlag, New York, NY. 1988. p 282-323, 14 tab, 7 fig, 5 ref.

Descriptors: *Regional analysis, *Optimum development plans, *Environmental protection, *Mineral industry, *Copper mining, *Nickel mining, *Environmental policy, Environmental protection, Regional planning, Multi-objective planning, Minnesota, Economic yield.

This study was conducted by the State of Minnesota to guide the development of major mineral resources of Cu, Ni, and Co in an orderly, comprehensive, and environmentally sound manner within the Superior National Forest and adjacent to the Boundary Waters Canoe Area, because of the potential for both economic benefits and widespread environmental damage. Background and baseline information was collected for land use, population, mineral resources, air quality, and water quality. Hypothetical mine/mill/smelter/refinery models were developed in order to put various environmental impacts into perspective. Actual development will probably be different from any of the models used in the assessment. Major trade-offs to be considered include: (1) mining or delayed mining; (2) open-pit mining or underground mining; (3) smelter in the Study Area, a remote smelter, or no smelter; and (4) development north or south of the Laurentian Divide. Based on air quality and water quality modeling predictions, a no impact requirement for the Boundary Water Canoe Area probably precludes siting a smelter in the Study Area. Although a smelter could be located elsewhere, a no impact requirement would probably preclude Cu-Ni mining and open-pit mining in the most sensitive areas. (See also W89-05568) (White-Reimer-PTT)
W89-05583

ENVIRONMENTAL MANAGEMENT OF NEW MINING OPERATIONS,
Ok Tedi Mining Ltd., Port Moresby (Papua New Guinea).
R. J. Higgins.
IN: Environmental Management of Solid Waste: Dredged Material and Mine Tailings. Springer-Verlag, New York, NY. 1988. p 372-391, 1 tab, 4 fig.

Descriptors: *Management planning, *Environmental protection, *Mining engineering, *Environmental policy, Mine wastes, Comprehensive planning, Monitoring, Project planning.

Sound environmental management, initiated and directed from within and pursued as an explicit corporate goal, is sound business practice for a mining venture. Environmental management programs should be conceptualized as the exploitation of the ore resource is undergoing conceptual design; during a feasibility study, it should be established that environmental factors will not prevent a project from being carried through; monitoring programs and control facilities should be designed during the engineering phase; and these programs and facilities should be up and running by the time the project is commissioned. A monitoring program can be builtup from a logical assessment of effluent sources, baseline conditions, impact predictions and environmental criteria. When the program is in place and operating, a responsive management approach with defined feedback loops can ensure that monitoring is producing appropriate management information, that the project's operations can be controlled and finetuned in a sound manner which recognizes environmental constraints, and that unexpected impacts are quickly detected and any necessary corrective action taken. (See also W89-05568) (White-Reimer-PTT)
W89-05585

LIMNOLOGY OF WEST POINT RESERVOIR, GEORGIA AND ALABAMA,
For primary bibliographic entry see Field 2H.
W89-05587

EVALUATING STRATEGIES FOR GROUNDWATER CONTAMINANT PLUME STABILIZATION AND REMOVAL,
S. M. Gorelick, and B. J. Wagner.
IN: Selected Papers in the Hydrologic Sciences 1986. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Supply Paper 2290. 1986. p 81-89, 7 fig, 11 ref.

Descriptors: *Water pollution treatment, *Groundwater pollution, *Plumes, *Groundwater movement, *Water pollution control, *Aquifer restoration, Simulation, Optimization, Model studies, Aquifer management, Groundwater recharge, Pumping.

Optimal remedial alternatives for contaminated aquifers can be selected by combining simulation and management models. Such models identify wells and pumping or recharge rates that will best stabilize contaminant plumes. Plumes may be contained by using pumping and recharge wells to control the hydraulic gradient at the perimeter of a plume. A procedure combining aquifer simulation with simple linear optimization was applied to a hypothetical system in which contaminated groundwater must be isolated and removed. Alternative aquifer restoration schemes were identified using hydraulic gradient control. Four steady-state examples demonstrated how selection of constraints and goals can provide the hydrologist with various schemes for stabilizing a contaminant plume. Experimenting with a variety of designs enables the user to identify acceptable solutions to site-specific problems of aquifer restoration. (See also W89-05586) (Rochester-PTT)
W89-05592

PLANNING FOR GROUNDWATER PROTECTION,
Academic Press, New York, NY, 1987. 387p. Edited by G. William Page.

Descriptors: *Groundwater pollution, *Water pollution control, *Planning, *Groundwater protection, *Water quality control, *Contamination, *Public health, Public policy, Legal aspects, Local governments, State jurisdiction, Federal jurisdiction, Hydrology, Hydrologic cycle.

Thirteen papers are presented that describe the major issues facing local, state, and federal jurisdictions when planning for groundwater protection. The book provides an overview of this topic and gives insight into how groundwater protection programs are developed and implemented. Descriptions of some of the best groundwater protection programs in the United States are presented. The concerns of state and local municipalities are discussed and include groundwater systems, fragmentation of laws and institutions, and political support. The arguments for planning better groundwater protection programs before there is serious contamination are stressed. (See W89-05601 thru W89-05613) (Stoehr-PTT)
W89-05600

INSTITUTIONAL FRAMEWORK FOR PROTECTING GROUNDWATER IN THE UNITED STATES,
Environmental Protection Agency, New York. Region II.
T. R. Henderson.
In: Planning for Groundwater Protection. Academic Press, New York, NY, 1987. p 29-67, 20 ref.

Descriptors: *Water law, *Legal aspects, *Federal jurisdiction, *State jurisdiction, *Drinking water, *Groundwater pollution, *Environmental protection, Groundwater, Toxicity, Protection, Regulations, Standards, Water quality.

The existing federal and state groundwater quality protection laws and institutions are described and a brief overview is given of efforts to improve the protection of this resource. Federal groundwater pollution control responsibilities are spread among at least eight laws: (1) Safe Drinking Water Act; (2) the Resource Conservation and Recovery Act; (3) the Comprehensive Environmental Response, Compensation, and Liability Act; (4) the Clean Water Act; (5) the Federal Insecticide Fungicide and Rodenticide Act; (6) the Toxic Substances Control Act; (7) the Atomic Energy Act; and (8) the Surface Mining Control and Reclamation Act. The EPA has developed a groundwater protection strategy which includes four major components: (1) helping states set up groundwater protection programs; (2) assessing inadequately addressed groundwater problems; (3) creating a policy framework for guiding EPA programs; and (4) strengthen internal groundwater organization. (See also W89-05600) (Stoehr-PTT)
W89-05602

DATA AND ORGANIZATIONAL REQUIREMENTS FOR LOCAL PLANNING,
Illinois Univ. at Chicago Circle. School of Urban Planning and Policy.
M. Jaffe.
In: Planning for Groundwater Protection. Academic Press, New York, NY, 1981. p 125-156, 2 tab, 21 ref.

Descriptors: *Water quality management, *Water pollution prevention *Planning, *Groundwater pollution, *Data collections, Water quality, Aquifers, Model studies.

This paper presents planners with basic information about the technical data required to develop local groundwater protection programs. Examples are given of local groundwater planning programs for communities throughout the nation. The historical basis of many of these local programs is pre-

sented. Technical information useful for groundwater planning includes the physical framework (hydrogeological maps, topographic maps, transmissivity maps, etc), hydrologic stresses (surface water diversions, groundwater pumpage, streamflow quality, areas of discharge and recharge), groundwater modeling and model calibration, and prediction and optimization analysis. A description is given which explains how this technical information can be translated into straightforward evaluations that identify groundwater threats and how these evaluations can help build public and political support for local protection programs. (See W89-05600) (Stoehr-PTT)
W89-05605

LONG ISLAND CASE STUDY,
Long Island Regional Planning Board, Hauppauge, NY.
L. L. Koppelman.
In: Planning for Groundwater Protection. Academic Press, New York, NY, 1987. p 157-203, 3 fig, 3 tab, 40 ref.

Descriptors: *Long Island, *New York, *Water pollution prevention, *Groundwater pollution, *Public participation, *Planning, Case studies, Topography, Permeability coefficient, Effluents, Wastewater treatment, Storm water, Recharge basins, Fertilizers, Pesticides, Legal aspects, Runoff.

A case study of Long Island and its specific characteristics in relation to groundwater management and water supplies is presented. This area's physical setting, groundwater system and groundwater problems are described. Existing pollution sources include domestic on-site waste disposal systems, sewage treatment plant effluents, stormwater basins, landfills, highway de-icing, fertilizers and pesticides, storage tanks and pipelines, airborne pollution, and spills and accidental discharges. A brief history is given of various institution's roles in groundwater management. Recommendations presented by these institutions are addressed, and alternatives to groundwater management such as land use controls and good management practices are shown to be an effective means of controlling groundwater pollution. Citizen participation was used successfully to increase the success of this area's groundwater protection programs. (See also W89-05600) (Stoehr-PTT)
W89-05606

DADE COUNTY, FLORIDA, CASE STUDY,
Dade County Planning Dept., Miami, FL.
R. R. Walters.
In: Planning for Groundwater Protection. Academic Press, New York, NY, 1987. p 205-239, 12 fig, 3 tab, 10 ref.

Descriptors: *Public policy, *Water quality management, *Water pollution prevention, *Florida, *Dade County, *Groundwater management, Groundwater pollution, Aquifers, Soil conservation, Geology, Wastewater treatment, Land use, Case studies.

Florida communities have been building directly on top of their drinking water reservoir, the Biscayne Aquifer. This building is posing significant water quality problems given the emerging knowledge regarding the contamination of groundwater with synthetic organic chemicals and the potential health effects of this contamination. The groundwater management programs in Dade County, Florida, that have been instituted to protect the quality of the Biscayne Aquifer are discussed. The location, climate, geology, soils, and recharge sources are discussed to give a background of this area's water supply needs and uses. The Wellfield Protection Study is examined to illustrate the communities involvement in developing policies and regulations governing groundwater quality. The five elements of the current wellfield protection program are: (1) water management and monitoring; (2) water and waste treatment facilities; (3) land use policies and controls; (4) environmental regulations and enforcement; and (5) public awareness and involvement. (See W89-05600) (Stoehr-PTT)
W89-05607

WAUSAU, WISCONSIN, CASE STUDY,
Wisconsin Univ.-Milwaukee. Dept. of Urban Planning.
G. W. Page.
In: Planning for Groundwater Protection. Academic Press, New York, NY, 1987. p 241-259, 2 fig, 4 tab, 18 ref.

Descriptors: *Water pollution prevention, *Water quality management, *Wisconsin, *Groundwater, *Groundwater pollution, *Water quality, Urban planning, Toxicity, Water supply, Organic compounds, Volatile solids, Case studies.

The state of Wisconsin through its Department of Natural Resources actively attempts to protect groundwater from toxic contamination and to respond to groundwater contamination events. Wisconsin has enacted one of the most thorough and comprehensive groundwater management acts in the nation. This paper describes the series of events that led to these regulations. The contamination of the water supply by industrial sources is outlined, and the steps taken to rectify these water quality problems is presented. Future development sites for new well fields for the city of Wausau and its surrounding municipalities are discussed. A regional water system is being considered. Advantages of a regional system include economies of scale, developing new well fields, and protecting the recharge areas of the new well fields. (See W89-05600) (Stoehr-PTT)
W89-05608

URBAN GROWTH MANAGEMENT AND GROUNDWATER PROTECTION: AUSTIN, TEXAS.
Lower Colorado River Authority, Austin, TX. Dept. of Natural Resource Policy and Programs.
K. S. Butler.
In: Planning for Groundwater Protection. Academic Press, New York, NY, 1987. p 261-287, 7 fig, 2 tab, 27 ref.

Descriptors: *Planning, *Water quality management, *Water pollution prevention, *Texas, *Groundwater pollution, *Urban planning, Aquifers, Storm water, Runoff, Public opinion, Watersheds, Watershed management.

The process of planning for the protection of groundwater used by the city of Austin, Texas is discussed. The effects that the ordinances for several watersheds and the associated aquifer will have on suburban land development and water quality protection for the Edwards Aquifer is discussed. The specific issues addressed in this discussion include the reasons for the Edwards Aquifer being so deserving of special protection in the face of urban expansion, how these development standards affect the planning of new subdivisions and site developments, and how groundwater quality protection standards operate in the broader context of growth management in this rapidly urbanizing region of central Texas. (See W89-05600) (Stoehr-PTT)
W89-05609

PERTH AMBOY, NEW JERSEY, CASE STUDIES,
Wisconsin Univ.-Milwaukee. Dept. of Urban Planning.
G. W. Page.
In: Planning for Groundwater Protection. Academic Press, New York, NY, 1987. p 289-298, 17 ref.

Descriptors: *Water quality management, *New Jersey, *Groundwater pollution, *Water quality, *Water supply, Case studies, Planning, Industrial water, Urban areas, Drinking water, Contamination, Toxicity, Polychlorinated biphenyls, Carcinogens.

A case study is presented of Perth Amboy, New Jersey that illustrates this area's particular groundwater quality problems and the solutions of these problems. Because this area had salt water intrusion in its water supply, the city had to acquire land in an undeveloped watershed in Middlesex County about 45 miles away. The history of toxics and nontoxics contamination problems that developed with this water supply is presented. The groundwater protection plans used by other municipalities are not available to Perth Amboy because its well field (the Runyon Well Field), is located in a different municipality. Perth Amboy could build expensive water treatment facilities (not presently needed) or purchase water from another source. (See W89-05600) (Stoehr-PTT)
W89-05610

SANTA CLARA VALLEY (SILICON VALLEY), CALIFORNIA, CASE STUDY,
Sunnyvale, CA.
T. Lewcock.
In: Planning for Groundwater Protection. Academic Press, New York, NY, 1987. p 299-324, 1 fig, 9 ref.

Descriptors: *Water pollution sources, *Water pollution prevention, *Legislation, *Underground storage, *Silicon Valley, *California, *Groundwater pollution, *Water quality management, Hazardous materials, Ordinances, Legal aspects, Water quality, Case studies, Storage tanks.

An overview, of the Santa Clara Valley is provided to give the background of this area's specific needs in regards to groundwater management. The water system of the Santa Clara Valley is described and includes a discussion of contamination sources in the valley. The primary focus of local and state officials is the leaking underground tanks that contain solvents and other hazardous chemicals used in the manufacturing process of the high technology industries in the area. The roles and responsibilities of federal, state, and regional governments are outlined with an emphasis on the implementation of the Model Storage Ordinance used to help solve the problems of the leaking tanks. The importance of cooperation among all interested parties is stressed. (See W89-05600) (Stoehr-PTT)
W89-05611

SOUTH BRUNSWICK, NEW JERSEY, CASE STUDY,
Wisconsin Univ.-Milwaukee. Dept. of Urban Planning.
G. W. Page.
In: Planning for Groundwater Protection. Academic Press, New York, NY, 1987. p 325-340, 2 fig, 19 ref.

Descriptors: *Water quality management, *Ordinances, *Water pollution prevention, *New Jersey, *Groundwater pollution, Contamination, Drinking water, Toxicity, Planning, Water supply, Municipal water, Case studies, Legal aspects.

The planning implications of toxic contamination of groundwater were examined by investigating a toxics pollution problem in the municipality of South Brunswick, New Jersey. South Brunswick is primarily a rural township in central New Jersey that has undergone rapid suburban growth in recent years. Planning for an adequate supply of potable water has become a serious constraint on growth in the town. The contamination of the town's water supply source with toxic substances has introduced a whole series of new and serious planning problems. A groundwater protection plan was developed which includes a new water treatment plant capable of removing a wide range of toxic contaminants, an environmental resource inventory with detailed information on the geology, topography, soils and water, a surveillance program, a local emergency response plan, and a land use planning process. (See also W89-05600) (Stoehr-PTT)
W89-05612

BEDFORD, MASSACHUSETTS, CASE STUDY,
B. J. Ram, and H. E. Schwarz.
In: Planning for Groundwater Protection. Academic Press, New York, NY, 1987. p 341-367, 2

fig, 2 tab, 30 ref.

Descriptors: *Legal aspects, *Massachusetts, *Drinking water, *Water quality management, *Water pollution prevention, Public health, Contamination, Water supply, Planning, Local governments, Water quality, Case studies, Litigation, Hazardous materials, Municipal water.

This case study of Bedford, Massachusetts, discusses groundwater management issues and describes the contamination of this municipal underground drinking water supply. Background of this area is provided, along with a description of the hydrogeology of the tributary watershed located in the town. The town's institutional structure is outlined, and each institution's role is described. Specific contamination problems are presented to illustrate the ways in which the township learned of the toxic contamination of their water supply. Results of the town's technical investigation were: (1) that industrial chemicals had been discharged to tributary watersheds of its four municipal wells; (2) that several sewer systems were probable sources of contaminants; (3) that major concentrations of contaminants could possibly be discharged from groundwater within 2-4 yr; and (4) that alternative water supplies be provided. Bedford filed suit against six local industries that allegedly caused the groundwater contamination. Bedford has begun to develop a range of nonstructural approaches to protect the remaining groundwater resources including zoning and land use controls. This paper brings to light several issues and problems relating to the protection of underground drinking water sources by local communities. (See W89-05600) (Stoehr-PTT)
W89-05613

RESEARCH ON WATER QUALITY OF RESERVOIR TAILWATERS,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
For primary bibliographic entry see Field 5B.
W89-05747

GROUNDWATER QUALITY: STATE ACTIVITIES TO GUARD AGAINST CONTAMINANTS.
General Accounting Office, Washington, DC.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-161724. Price codes: A06 in paper copy, A01 in microfiche. Report No. GAO/PEMD-88-5, February 1988. 166p, 13 fig, 19 tab, 10 ref, 5 append.

Descriptors: *Water law, *State jurisdiction, *Standards, *Water quality control, *Water pollution prevention, *Groundwater quality, Regulations, Groundwater pollution.

This report focuses on state groundwater standards activities. The federal role in dealing with the problem has been largely supportive and the Congress has been considering whether the role is sufficient. The study examines what the states are doing in setting standards to protect groundwater in terms of the context within which the states establish standards, which states have set groundwater standards for what contaminants, how the standards differ across the states, how the states have developed their standards, and how they use the standards. Forty-one states have either numeric or narrative standards. Almost half the states, have 1,019 numeric standards cover 250 physical characteristics of groundwater. Except for the standards that follow the federal drinking water standards, there is little uniformity. The numeric standards established by the various states are tabulated. (Lantz-PTT)
W89-05765

GEOCHEMICAL MODELING RESEARCH RELATED TO THE SURFACE DISPOSAL OF PROCESSED OIL SHALE SOLID WASTE,
University of Wyoming Research Corp., Laramie. Western Research Inst.
For primary bibliographic entry see Field 5E.
W89-05768

OUR NATIONAL HERITAGE: A PROTECTION GUIDEBOOK,
For primary bibliographic entry see Field 6E.
W89-05770

OPERATIONAL, SPATIAL, AND ENVIRONMENTAL WATER PLANNING AND ANALYSIS-PHASE II,
Michigan State Univ., East Lansing. Dept. of Resource Development.
B. C. Bill, and J. F. Bartholic.
Available from National Technical Information Service, Springfield, VA 22161 as PB89-102198/AS, price codes: A05 in paper copy, A01 in microfich. Michigan Institute of Water Research, E. Lansing. Technical Report No. G1429-04, April 1988. 49 p, 17 fig, 6 tab, 11 ref, append. Contract 14-08-0001-G1429. Project USGS G1429-04.

Descriptors: *Model studies, *Computer models, *Nonpoint Source Pollution Model, *Watershed management, AGNPS, Best management practice, Phosphorus, Nutrients, Michigan, Nonpoint pollution sources, Little Swan Creek Watershed.

The Agricultural Nonpoint Source Pollution Model (AGNPS) was applied in the Little Swan Creek Watershed in Branch County, Michigan. The model was verified within the conditions of southern Michigan and a sensitivity analysis conducted. The model was evaluated for its user friendliness and ease of use by potential users. The application of AGNPS has demonstrated the model's potential for assisting water quality planners in the monumental task of contolling nonpoint sources pollution. The model was indispensable in identifying priority areas required by the Clean Water Incentive program. Without such a model, it would have been impossible to identify these areas without taking expensive and time-consuming measurements. The model has also demonstrated its potential usefulness by allowing watershed coordinators and land managers a look into the future to see how changes in tillage, fertilizer practices and crop rotation affect surface water quality. (See also W88-00943) (USGS)
W89-05772

6. WATER RESOURCES PLANNING

6A. Techniques Of Planning

THIRD CARIBBEAN ISLANDS WATER RESOURCES CONGRESS.
Proceedings of a Symposium held in St. Thomas, U.S. Virgin Islands, July 22-25, 1986. Puerto Rico Water Resources Association. 1986. 95p. Edited by Ferdinand Quinones, Ana V. Sanchez, and Henry H. Smith.

Descriptors: *Water resources development, *Water management, *Caribbean, *Water supply, Precipitation, Water quality, Information systems, Groundwater quality, Groundwater budget, Geochemistry, Simulation analysis, Aquifers, Conferences.

Water has become a critical commodity in the Caribbean Region. In spite of a relative abundance of rainfall even on the smaller islands, the region is faced with severe seasonal shortages as well as increasing water quality problems. The supply of the water needs in the area will become even more critical as economic development accelerates and the population continues to increase. The development of the necessary infrastructure to supply the water needs of the next 30 years will require large capital investments. Perhaps even more important, it will require training of scientists and technicians in the investigation and management of the limited water resources. The lack of trained personnel could be the most important factor in the solution of the water resources problems in the region. The principal objectives of this 'Third Caribbean Islands Water Resources Congress', were to provide a focus for the transfer of technology on hydrology and water resources investigations in the region. The severe quality problems that affect water supplies in the U.S. Virgin Islands are the subject of two papers. The importance of a reliable data base on water use in small islands is considered in a paper on water use in St. Croix. Advanced techniques are discussed on how to measure groundwater contributions to runoff, use of geochemical techniques for interpretation of water quality characteristics, use of dye tracers in karst areas, simulation of small island's aquifers, and use of borehole geophysical tools to estimate moisture. The contamination of groundwater resources is discussed in several papers focusing on monitoring, sludge management, and environmental assessment. (See W89-04666 thru W89-04682) (Lantz-PTT)
W89-04665

GREAT LAKES STORM SURGE PLANNING PROGRAM (SSPP),
National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.
D. J. Schwab, and E. W. Lynn.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-119433. Price codes: A03 in paper copy, A01 in microfiche. NOAA Technical Memorandum ERL GLERL-65, August 1987. 9p, 5 ref, 2 append.

Descriptors: *Storm surges, *Seiches, *Great Lakes, *Storms, *Computer programs, Water level, Flood control, Lake Erie, Lake Ontario, Lake Huron, Lake Michigan, Lake Superior.

A computer program for estimating maximum and minimum storm surge water levels for the Great Lakes is reported. Storm surge water levels for a given wind speed and wind direction can be calculated for Lake Ontario, Central and Eastern Lake Erie, Western Lake Erie, Lake St. Clair, Lake Huron, Saginaw Bay, the eastern shore of Lake Michigan, the western shore of Lake Michigan, Green Bay, or Lake Superior. The program can be run on any PC-type computer. (Author's abstract)
W89-04840

EFFECTIVENESS OF BMPS FOR STORMWATER MANAGEMENT IN URBANIZED WATERSHEDS,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5G.
W89-04873

DECISION SUPPORT SYSTEM FOR SELECTING INPUTS TO A BASIN SCALE MODEL,
Agricultural Research Service, Temple, TX. Soil and Water Conservation Research Div.
For primary bibliographic entry see Field 7A.
W89-05265

ASSESSMENT OF THE OPERATIONS AND MAINTENANCE COMPONENT OF WATER SUPPLY PROJECTS,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
For primary bibliographic entry see Field 5F.
W89-05516

COMMUNITY DEVELOPMENT WORKER TRAINING FOR THE SHABA REFUGEE WATER SUPPLY PROJECT IN ZAIRE,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
S. C. Ford.
Water and Sanitation for Health Project, Washington, DC. WASH Field Report No. 178, April 1986. 36p, 5 append. AID Contract 5942-C-00-4085-00, Project 936-5942.

Descriptors: *Developing countries, *Training, *Water supply development, *Zaire, Public participation, Wells, Evaluation, Water resources development, Boreholes.

At the request of the USAID Mission in the Republic of Zaire, the Water and Sanitation for

Health (WASH) Project was authorized by USAID's Office of Health in Washington, DC., to send a consultant to Zaire in January 1986 to train community development workers for the Shaba Refugee Water Supply Project (116) in Sandoa, Shaba. A three-week participatory, community-based training program was designed in the United States for implementation at project headquarters in Sandoa. Community development workers (CDW) were trained to help communities participate fully in selecting, constructing, and maintaining project water systems. Included in this report are descriptions of the planning and implementation phases of the training, an assessment of the training, and recommendations for future training programs. The consultant's recommendations include: (1) Training logistics coordinator should be appointed as a liaison between the trainers and the Project 116 administrative assistant and should be responsible for all of the logistical arrangements for the training; (2) A greater number of communities willing to participate in training should be contacted well in advance of the actual training; (3) For the CDW to be competent to explain the different systems and discuss their advantages and disadvantages with communities, they need to have a thorough understanding of the systems' construction and maintenance steps; (4) Developing community participation strategies for borehole wells should take place approximately two months before the drilling equipment is scheduled to arrive in Sandoa; and (5) The training of village water committee trainers should take place approximately one month before the drilling equipment is scheduled to arrive in Sandoa and several weeks after the CDW have designed and tested the community participation strategies for communities with borehole wells. (Lantz-PTT)
W89-05521

TRAINING OF TRAINERS WORKSHOP AND TRAINING MATERIALS DEVELOPMENT FOR THE WATER AND SANITATION COMPONENT OF SANRU II,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
H. L. Jennings, and P. Gaye.
Water and Sanitation for Health Project, Washington, DC. WASH Field Report No. 177, April 1986. 62p, 4 append. AID Contract 5942-C-00-4085-00, Project 936-5942.

Descriptors: *Developing countries, *Management planning, *Training, *Education, *Water management, *Zaire, *Sanitation, Water resources development, Evaluation, Rural areas.

The WASH Project assisted the USAID Mission in Zaire, under Activity No. 221, to develop a national training capacity for the Government of the Republic of Zaire's (GOZ) rural water supply and sanitation sector. Two consultants trained a team of core trainers and assisted the trainers in the development of designs, curricula and materials. In 1985, USAID/Zaire requested WASH assistance in developing an overall strategy and training plan for the water and sanitation component of the SANRU II Project. The purpose of the SANRU II Project is to establish sustainable community-supported primary health care systems in 50 rural health zones in Zaire. The water and sanitation component of the SANRU II Project includes two separate but interrelated elements. The first supports SANRU II-assisted rural health zones to improve their ability to plan and carry out water and sanitation activities. The second helps to strengthen the National Rural Water Service (SNHR), which is responsible for constructing rural water systems throughout Zaire. All the various evaluation instruments indicated a consistently high degree of satisfaction with the training of trainers (TOT) workshop. The consultants recommend several important steps in the implementation of the training strategy. Among these recommendations were the following: (1) Church of Christ of Zaire and SNHR should create a training coordinating committee; (2) SNHR should consider designating a full-time training coordinator; and (3) Debriefings should be held with the national training team after the first round of workshops. (Lantz-PTT)
W89-05522

TRAINING OF TRAINERS IN MALAWI'S HEALTH EDUCATION AND SANITATION PROMOTION (HESP) PROGRAM (PHASE TWO),
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
For primary bibliographic entry see Field 5F.
W89-05528

TOWARDS A LONG-TERM BALANCE BETWEEN ECONOMICS AND ENVIRONMENTAL PROTECTION,
Heidelberg Univ. (Germany, F.R.). Alfred Weber-Inst.
For primary bibliographic entry see Field 5G.
W89-05581

ENVIRONMENTAL MANAGEMENT OF NEW MINING OPERATIONS,
Ok Tedi Mining Ltd., Port Moresby (Papua New Guinea).
For primary bibliographic entry see Field 5G.
W89-05585

DATA AND ORGANIZATIONAL REQUIREMENTS FOR LOCAL PLANNING,
Illinois Univ. at Chicago Circle. School of Urban Planning and Policy.
For primary bibliographic entry see Field 5G.
W89-05605

REGIONAL FLOOD FREQUENCY ANALYSIS: PROCEEDINGS OF THE INTERNATIONAL SYMPOSIUM ON FLOOD FREQUENCY AND RISK ANALYSES, 14-17 MAY 1986, LOUISIANA STATE UNIVERSITY, BATON ROUGE, U.S.A.
For primary bibliographic entry see Field 2E.
W89-05614

SENSITIVITY CONSTRAINED NONLINEAR PROGRAMMING: A GENERAL APPROACH FOR PLANNING AND DESIGN UNDER PARAMETER UNCERTAINTY AND AN APPLICATION TO TREATMENT PLANT DESIGN,
Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.
J. G. Uber, J. J. Kao, E. D. Brill, and J. T. Pfeffer.
Available from National Technical Information Service, Springfield, VA 22161 as PB88-199922/AS, price codes: A11 in paper copy, A01 in microfiche. Final Report, (1988). 218 p, 30 fig, 21 tab, 60 ref, 3 append. Contract 14-08-0001-G1144. Project USGS G1144.

Descriptors: *Robustness, *Nonlinear programming, *Design, *Wastewater treatment, *Risks, *Optimization, Reliability, Planning, Activated sludge, Nonlinear programming, Systems analysis, Model studies, Computer programs.

One important problem with using mathematical models is that parameter values, and thus the model results, are oftem uncertain. A general approach, Sensitivity Constrained Nonlinear Programming (SCNLP), was developed for extending nonlinear optimization models to include functions that depend on the system sensitivity to changes in parameter values. Such sensitivity-based functions include first-order measures of variance, reliability, and robustness. Thus SCNLP can be used to generate solutions or designs that are good with respect to modeled objectives, and that also reflect concerns about uncertainty in parameter values. A solution procedure and an implementation based on an existing nonlinear programming code are presented. SCNLP was applied to a complex activated sludge wastewater treatment plant design problem. The alternative designs generated represent the tradeoff between cost and system robustness, where robustness is related inversely to the sensitivity of effluent qualoty to changes in 55 parameter values. The results show a significant tradeoff between cost and robustness and significant design trends associated with improvements in robustness. These design trends are generally more consistent with recommended design practice than is the minimum cost design. SCNLP should be applicable to many problems where parameter value uncertainty is important, e.g., the design of contaminated groundwater remediation schemes. (USGS)
W89-05789

6B. Evaluation Process

THIRD CARIBBEAN ISLANDS WATER RESOURCES CONGRESS.
For primary bibliographic entry see Field 6A.
W89-04665

EPA'S WASTE MINIMIZATION RESEARCH PROGRAM,
Environmental Protection Agency, Cincinnati, OH. Hazardous Waste Engineering Research Lab.
For primary bibliographic entry see Field 5E.
W89-04749

INTERLABORATORY EVALUATION OF ICP-AES METHOD 6010,
Environmental Monitoring Systems Lab., Las Vegas, NV.
For primary bibliographic entry see Field 5A.
W89-04821

RCRA LABORATORY CERTIFICATION,
New Jersey Dept. of Environmental Protection, Trenton. Office of Quality Assurance.
R. R. Hirst, D. M. Stainken, R. L. Fischer, and K. L. Stauber.
IN: Waste Testing and Quality Assurance. American Society for Testing and Materials, Philadelphia, PA. Special Technical Publication 999, 1988. p 81-86, 2 tab.

Descriptors: *Quality control, *Environmental protection, *Environmental policy, *Water policy, *Laboratories, *Pollutant identification, Waste characteristics, Administrative regulations, Drinking water, Quality control, New Jersey, Organic compounds, Chemical analysis, Water analysis, Water pollution control.

The Office of Quality Assurance (OQA) within the New Jersey Department of Environmental Protection develops laboratory standards for the Department's Safe Drinking Water and NPDES (NJPDES) programs, and administers a laboratory certification program. The existing certification program was first promulgated for drinking water in 1977. Certification for water and wastewater was offered beginning in 1981. The USEPA Region II RCRA staff incorporated a work output in the FY 1986 USEPA/NJDEP RCRA Interagency Agreement that requires the Department to begin evaluating compliance and performance of analytical laboratories which report measurement data to the Agency and the Department with respect to the RCRA program. OQA made a decision to develop a laboratory certification program for waste analyses (RCRA) and to incorporate such a program into its current regulations. The RCRA laboratory certification program, as it is currently proposed, would provide laboratories with certification in four major categories: waste characterization, inorganics, organics, and miscellaneous analyses. Laboratories will be certified by individual parameter or analysis under the categories of waste characterization, inorganics (AAS), and miscellaneous analyses. For organics analyses, laboratories will be certified for entire analytical methods rather than by individual analytes (for example, a laboratory will be certified for all parameters covered under SW-846 Method 8240 rather than by each individual analyte listed in the method). Laboratories will be requested at the time they apply for certification to designate which matrices (aqueous and/or nonaqueous) will be analyzed under their RCRA certification. The program will require, along with NJDEP's RCRA regulations, that all laboratories that submit RCRA compliance data to the Department must be certified for the applicable parameters or methods. (See also W89-04816) (Author's abstract)
W89-04822

Group 6B—Evaluation Process

APPLICATION OF AN EFFICIENT NONLINEAR REGRESSION TECHNIQUE FOR SEWER COST MODELLING,
National Univ. of Singapore. Dept. of Civil Engineering.
S. L. Ong.
Water, Air, and Soil Pollution WAPLAC, Vol. 38, No. 3-4, p 365-377, April 1988. 8 tab, 17 ref.

Descriptors: *Model studies, *Statistical models, *Cost analysis, Regression analysis, *Sewers, *Wastewater treatment, Planning.

The effectiveness of an efficient nonlinear regression technique for estimating the empirical parameters associated with separable and generalized models was investigated. The nonlinear regression technique employed is particularly useful for models in which linear and nonlinear parameters are separable in that only the values of the nonlinear parameters need to be optimized. Thus, the use of this algorithm need only provide a set of initial guessed solutions for the nonlinear parameters, which is much easier to estimate than the linear one. In addition, the regression technique can be implemented on a microcomputer. The computation experience gained indicates that the nonlinear regression technique investigated is capable of obtaining a set of good estimates for the empirical constants contained in the two types of cost models studied under a wide range of noise levels incorporated. Besides, the algorithm was quite insensitive to the initial guessed solution for the case of a separable model. The generalized cost model, on the other hand, was also found to be insensitive to the initial guessed solution when the noise level incorporated is not higher than a level of 0.25. For both types of cost models, the mean of absolute percentage error with respect to the perfect data was consistently smaller than that with respect to data with built-in error. Thus, one can conclude that the two types of models studied are not too sensitive to minor errors in the estimated values of its model parameters. (Miller-PTT)
W89-05000

EVALUATION AND IMPROVEMENT OF HYDROLOGICAL CONCEPTS USED IN PAWN,
Rijksinstituut voor Zuivering van Afvalwater, Lelystad (Netherlands).
G. E. Arnold, and W. E. van Vuuren.
Agricultural Water Management AWMADF, Vol. 14, No. 1-4, p 219-230, August 1988. 4 fig, 1 tab, 11 ref.

Descriptors: *Management planning, *Water management, *Hydrologic models, *Mathematical models, *Agricultural hydrology, *The Netherlands, Evaluation, Hydrologic aspects, Model testing, Unsaturated flow, Sensitivity analysis.

In the years 1976-1983 the PAWN study (Policy Analysis for the Water-management in the Netherlands) was carried out in order to assess data for a national water management policy. Among the mathematical models used in PAWN, DEMGEN (DEMand GENerator) represents agriculture. By simulating the hydrological cycle in agricultural areas the model produces data on sprinkling demand, total water demand, agricultural damage and the changes in groundwater levels due to water suppletion. The results of a critical evaluation of DEMGEN, specifically with regard to future applications are presented. Physical concepts discussed include unsaturated flow, evapotranspiration, drainage, and irrigation. Most studies summarized deal with separate concepts, but there is also data from an integral sensitivity analysis and a validation of DEMGEN on the basis of data from two experimental catchments in the Netherlands. (Author's abstract)
W89-05128

REGRESSION EQUATIONS FOR LAKE MANAGEMENT: HOW FAR DO THEY GO,
Senter for Industriforskning, Oslo (Norway).
For primary bibliographic entry see Field 5G.
W89-05171

OYSTER AND SHRIMP PRODUCERS IN ESTUARINE AREAS OF THE GULF OF MEXICO: ECOLOGICAL CONSTRAINTS, ECONOMIC INCENTIVES AND CONFLICTUAL MANAGEMENT,
Laval Univ., Quebec. Dept. de Anthropologie.
Y. Breton, and E. Lopez Estrada.
Journal of Shellfish Research JSHRDA, Vol. 7, No. 2, p 319-326, October 1988. 2 fig, 25 ref. Social Sciences Research Council of Canada Grant 410-83-1124.

Descriptors: *Estuarine fisheries, *Shellfish farming, *Gulf of Mexico, *Fish management, *Mexico, Oysters, Shrimp, Resources management, Economic aspects, Political aspects.

Five major estuarine areas sustain the conduct of fishing activities in the Gulf of Mexico. In spite of strong similarities, mainly based on the exploitation of two major species, oyster and shrimp, each area is characterized by a differential social and economic basis in which the growth of capitalism generates conflicts of various intensity. This paper focuses on two major fishing centers, Alvarado in the state of Veracruz and Ciudad del Carmen in the state of Campeche, Mexico. It is shown how opposite forms of resources management, partially rooted in some specific ecological features, arose from different forms of capital management and political power of groups of producers. Even though the state has been seeking to promote the development of fishing, it has done little to prevent pollution of the estuaries by industrial activities, e.g. papermills, sugar cane producers, and the petroleum industry. (VerNooy-PTT)
W89-05241

VALUE OF WATER SUPPLY AND SANITATION IN DEVELOPMENT: AN ASSESSMENT,
North Carolina Univ. at Chapel Hill. Dept. of Environmental Sciences and Engineering.
For primary bibliographic entry see Field 5F.
W89-05321

ENVIRONMENTAL MANAGEMENT OF NEW MINING OPERATIONS IN DEVELOPED COUNTRIES: THE REGIONAL COPPER-NICKEL STUDY,
Indiana Univ.-Purdue Univ. at Indianapolis.
For primary bibliographic entry see Field 5G.
W89-05583

DECISION-MAKING FRAMEWORK FOR MANAGEMENT OF DREDGED MATERIAL DISPOSAL,
Army Engineer Waterways Experiment Station, Vicksburg, MS.
For primary bibliographic entry see Field 5E.
W89-05584

ENVIRONMENTAL POLICY IN BRITAIN: REAFFIRMATION OR REFORM,
Imperial Coll. of Science and Technology, London (England).
For primary bibliographic entry see Field 6E.
W89-05767

OPERATIONAL, SPATIAL, AND ENVIRONMENTAL WATER PLANNING AND ANALYSIS-PHASE II,
Michigan State Univ., East Lansing. Dept. of Resource Development.
For primary bibliographic entry see Field 5G.
W89-05772

ECONOMIC STUDY FOR THE POTENTIAL FOR WATER MARKETS IN IDAHO,
Washington State Univ., Pullman. Dept. of Agricultural Economics.
N. Whittlesey, J. Hamilton, and P. Halverson.
Available from National Technical Information Service, Springfield, VA 22161 as PB89-101992/AS, price codes: A07 in paper copy, A01 in microfich. Idaho Water Resources Research Institute, Moscow, Project Completion Report, December 1986. 136 p, 2 fig, 33 tab, 19 ref, 2 append. Contract 14-08-0001-G1259. Project USGS G1259-02.

Descriptors: *Water market, *Hydropower, *Irrigation, *Idaho, *Water costs, *Economic evaluations, Cost projections, Stored water, Market value, Option lease programs, Agricultural water use, Water demand.

This study investigated the economic potential for water markets that would exchange water from irrigated agricultural to hydropower production in southern Idaho. Two kinds of water market were considered. The first involved the marketing of stored water that is now owned by agricultural interests but is seldom used for irrigation. The second was an option lease program that would depend on water currently used for irrigation. A market for stored water is currently working but could be modified to increase the market value of the water. The value that could be created by selling stored water for hydropower far exceeds its current value in storage or for cultural uses. It is conservatively estimated that the power value of this water ranges from $10 to $22 per acre-foot, while the current price being paid for power production is $2.50 per acre-foot. The option lease program also appears to be economically feasible. This program would allow agriculture to use the water in most years and require its use for hydropower only during critical flow periods. Thus, agriculture remains intact while the water continues to create value in hydropower. The program analyzed would reduce average agricultural income about $2.50 per acre while the value of hydropower created would be about ten times this amount. (USGS)
W89-05777

6C. Cost Allocation, Cost Sharing, Pricing/Repayment

COST EFFECTIVENESS OF THE STREAM-GAGING PROGRAM IN MISSOURI,
Geological Survey, Rolla, MO. Water Resources Div.
For primary bibliographic entry see Field 7B.
W89-04898

COST EFFECTIVENESS OF THE U.S. GEOLOGICAL SURVEY'S STREAM-GAGING PROGRAM IN WISCONSIN,
Geological Survey, Madison, WI. Water Resources Div.
For primary bibliographic entry see Field 2E.
W89-04909

ESTIMATING RESIDENTIAL PRICE ELASTICITY OF DEMAND FOR WATER: A CONTINGENT VALUATION APPROACH,
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
For primary bibliographic entry see Field 6D.
W89-05055

MULTIOBJECTIVE ALLOCATION OF WATER SHORTAGE IN THE SVARTA RIVER, SWEDEN,
Manitoba Univ., Winnipeg. Dept. of Civil Engineering.
For primary bibliographic entry see Field 6D.
W89-05266

WILLINGNESS TO PAY FOR WATER IN RURAL AREAS: METHODOLOGICAL APPROACHES AND AN APPLICATION IN HAITI,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
For primary bibliographic entry see Field 5F.
W89-05384

WATER VENDING AND DEVELOPMENT: LESSONS FROM TWO COUNTRIES,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
D. Whittington, D. Lauria, D. A. Okun, and X.

Mu.
Water and Sanitation for Health Project, Washington, DC. WASH Technical Report No. 45, May 1988. 53p, 16 fig, 7 tab, 15 ref. AID Contract 5942-C-00-4085-00, Project 936-5942.

Descriptors: *Economic aspects, *Water supply development, *Developing countries, *Kenya, *Honduras, Water conveyance, Rural areas, Urban areas, Water costs, Costs, Finances.

Millions of people in developing countries obtain water from commercial vendors who deliver it to their houses. This water is very expensive, whether delivered by men, animals, or motorized vehicles. Households supplied by vendors generally pay more for 20 liters of water than those supplied 500 liters per day from a piped system. Despite the fact that water vending is ubiquitous in the Third World, it has received little attention and is not well understood. To address this problem, the WASH project and a research team from the University of North Carolina (UNC) conducted two in-depth studies, one in a village in Kenya and the other in a periurban area in Honduras, in order to understand how vending systems operate and how they can be improved. Both studies showed that vendors do not earn large profits, making government regulation to limit exploitation unnecessary. The research provides concrete evidence that households are able and willing to pay substantial amounts of money for water, much more than would be necessary for a piped distribution system with yard taps (a new piped system with yard taps could be built in Ukunda, Kenya for an annual per capita cost of about US $10-$15). This finding is important because funds from donor agencies and national governments are simply not sufficient to make grants for improved water services in developing countries. The study also indicates that vending has several advantages in comparison to other water delivery systems: vending systems can play a potentially valuable role in bridging the time from when a community can afford only a few improved water sources until the time when incomes increase to a level which can support a piped system with private yard taps or house connections. Vending systems permit households to adjust their water purchases to fit their cash flow, and operate with low economies of scale and flexibility. Where alternate sources of water are available, a study of vending can indicate the extent to which convenience is valued. In both Ukunda and Tegucigalpa, Honduras people were willing to pay significant sums for having water delivered to their homes. (Lantz-PTT)
W89-05519

6D. Water Demand

WATER USE IN MARYLAND,
Maryland Geological Survey, Baltimore.
J. C. Wheeler.
Maryland Geological Survey, (Baltimore), 1983. 1p, 11 fig, 22 ref.

Descriptors: *Water use, *Maryland, Surface waters, Water supply, Groundwater, Industrial water, Municipal water, Irrigation.

Maryland has an area of 12,303 sq mi, with 1,725 sq mi (141 human population%) being water, most of which is saline or brackish. The total population of the State based on the 1980 Census was 4,216,446, and the first figure shows the distribution of the State population by county. Surface streams are the suppliers of most of the water used in the Piedmont, Blue Ridge, Valley and Ridge, and Appalachian Plateau Provinces of the State. Groundwater supplies are not as abundant in these provinces because the low permeability of the consolidated rocks underlying them are only able to provide relatively small amounts of water. Groundwater sources supply most of the water used in the Coastal Plain, as the vast network of unconsolidated sand aquifers underlying this province yield large quantities of water. Surface water sources in the Coastal Plain are minimally used because many of the streams have insufficient flow or are too brackish or saline for most uses. Increasing demands of growing population, industrial development, and electrical power generation have placed stress on the State's sources of water supply. Efficient management of these water resources requires that the amount of water used and the type and location of that use be determined. Once collected, water use data will help evaluate the effects of present withdrawals and anticipate the impact of future water demands. This report summarizes water use data as the average quantities withdrawn daily in units of millions of gallons per day (Mgal/d). The five categories of use considered are: (1) Public supply; (2) Thermoelectric power generation; (3) Industrial (self-supplied); (4) Irrigation; and (5) Rural (self-supplied). Uses not involving the withdrawal of water such as recreation, navigation, preservation, or in-stream use for the generation of hydroelectric power are not included in this report. (Lantz-PTT)
W89-04631

ESTIMATED WATER USE IN ST. CROIX, U.S. VIRGIN ISLANDS, 1983-1985,
H. Torres-Sierra.
IN: Third Caribbean Islands Water Resources Congress. Proceedings of a Symposium held in St. Thomas, U.S. Virgin Islands, July 22-25, 1986. p 7-11, 6 fig, 3 ref.

Descriptors: *Water use, *St. Croix, *Water management, *Water resources, *Virgin Islands, Surveys, Seawater, Groundwater budget, Desalination, Saline water.

A generalized water use inventory in St. Croix, U.S. Virgin Islands was conducted from September 1983 to October 1985. The inventory showed that about 73.18 million gpd (gallons per day) of water are used, of which 98% is seawater. Groundwater use is about 1.29 million gpd, while rainfall catchments provide 0.49 gpd. About 35.4 million gpd of seawater are used by desalination plants to produce about 3.5 million gpd of freshwater. Only 66% of the production from the desalination plants is accounted for. (See also W89-04665) (Author's abstract)
W89-04667

HISTORY OF GROUND-WATER PUMPAGE AND WATER-LEVEL DECLINE IN THE BLACK CREEK AND UPPER CAPE FEAR AQUIFERS OF THE CENTRAL COASTAL PLAIN OF NORTH CAROLINA,
Geological Survey, Raleigh, NC. Water Resources Div.
For primary bibliographic entry see Field 4B.
W89-04939

WATER SUPPLIES IN WESTERN KENTUCKY DURING 1984,
Geological Survey, Louisville, KY. Water Resources Div.
For primary bibliographic entry see Field 5F.
W89-04941

GROUND-WATER PUMPAGE FROM THE COLUMBIA PLATEAU REGIONAL AQUIFER SYSTEM, OREGON, 1984,
Geological Survey, Portland, OR. Water Resources Div.
C. A. Collins.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4211, 1987. 21p, 1 plate, 6 fig, 2 tab, 11 ref.

Descriptors: *Water use, *Pumpage, *Aquifer analysis, *Oregon, *Groundwater, Columbia River, Aquifers.

Groundwater pumpage was estimated for 1984 for an area of about 8,000 sq mi in north-central Oregon. Pumpage data were collected from irrigation, industrial and public supply users and analyzed as part of the Columbia Plateau Regional Aquifer System Analysis (RASA) study. Groundwater is pumped from Tertiary basalts and interflow material of the Columbia River Basalt Group and the overlying Tertiary-Quaternary sedimentary material. Pumpage was estimated from flowmeter data for about two-thirds of the area. For wells without flowmeters, pumpage was estimated from power-consumption data, if available, or from irrigated acreage data, using an areally adjusted application rate. The total amount of water pumped during 1984 was estimated to be about 148,000 acre-feet. (Author's abstract)
W89-04967

BENEFITS OF INCREASED STREAMFLOW: THE CASE OF THE JOHN DAY RIVER STEELHEAD FISHERY,
Oregon State Univ., Corvallis. Dept. of Agricultural and Resource Economics.
N. S. Johnson, and R. M. Adams.
Water Resources Research WRERAO, Vol. 24, No. 11, p 1839-1846, November 1988. 1 fig, 3 tab, 33 ref.

Descriptors: *Instream water use, *Water use, *Fisheries, *Stream fisheries, *Streamflow, *Economic evaluation, John Day River, Sport fishing, Trout, Cost-benefit analysis, Oregon.

Conflicts between instream water uses such as fish production and traditional out-of-stream uses are an important water resource issue. One criterion for evaluating the merits of alternative water allocations is economic efficiency. An integrated approach was used to measure the recreational steelhead fishery benefits of incremental streamflow changes in the John Day River in Oregon. The analysis combines a steelhead fishery production model with a contingent valuation assessment of changes in fishing quality to obtain estimates of the marginal value of water in producing fishing quality. The results suggest that increased summer flows to enhance fishing have a marginal value of about $2.40 acre-foot. When expressed in terms of water actually consumed, the value may be up to 10 times higher. These values are sensitive to the location of flow alterations in the river, potential for downstream uses and number of anglers in the fishery. (Author's abstract)
W89-05054

ESTIMATING RESIDENTIAL PRICE ELASTICITY OF DEMAND FOR WATER: A CONTINGENT VALUATION APPROACH,
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
J. F. Thomas, and G. J. Syme.
Water Resources Research WRERAO, Vol. 24, No. 11, p 1847-1857, November 1988. 1 fig, 11 tab, 24 ref.

Descriptors: *Water demand, *Water supply, *Municipal water, *Domestic water, *Pricing, *Economic evaluation, Groundwater, Time series analysis, Perth, Australia, Public opinion.

Residential households in Perth, Western Australia have access to privately extracted groundwater as well as a public mains water supply, which has been charged through a 2-part block tariff. A contingent valuation approach was developed to estimate price elasticity of demand for public supply. Results are compared with those of a multivariate time series analysis. Validation tests for the contingent approach are proposed, based on a comparison of predicted behaviors following hypothesized price changes with relevant independent data. Properly conducted, the contingent approach appears to be reliable, applicable where the available data do not favor regression analysis, and a fruitful source of information about social, technical, and behavioral responses to change in the price of water. (Author's abstract)
W89-05055

EVALUATION AND IMPROVEMENT OF HYDROLOGICAL CONCEPTS USED IN PAWN,
Rijksinstituut voor Zuivering van Afvalwater, Lelystad (Netherlands).
For primary bibliographic entry see Field 6B.
W89-05128

MULTIOBJECTIVE ALLOCATION OF WATER SHORTAGE IN THE SVARTA RIVER, SWEDEN,
Manitoba Univ., Winnipeg. Dept. of Civil Engineering.
I. C. Goulter, and R. Castensson.
Water Resources Bulletin WARBAQ, Vol. 24, No. 4, p 761-773, August 1988. 2 fig, 5 tab, 9 ref, append.

Descriptors: *Water demand, *Model studies, *Water allocation, *Water shortage, *Sweden, *Water supply, Water use, Water distribution, Optimization, Water permits, Hydrologic properties, Hydroelectric power, Deterministic models, Irrigation requirements, Urban watersheds.

A model is proposed for allocation of water shortages among competing water uses in the Svarta River basin in Sweden. The three major competing uses in the basin are hydroelectricity generation, irrigation water supply, and urban water supply. Minor uses that impact upon the allocation are minimum river flow requirements for fishlife and for dilution of treated wastewater, and storage level restrictions for recreation purposes in the main storage facility, Lake Sommen. Analysis of the competing demands on the water are modeled through the method-of-weights multiobjective technique using a deterministic mixed-integer optimization formulation. The (0-1) variables in the formulation are required to synthesize the restricted validity of permits for withdrawal of irrigation water from the river and to simulate the complex operating rules of the major regulation facility on the river. Due to the deterministic nature of the formulation, the model is used on a hydrologic scenario basis. Use of the model is demonstrated by application to the Svarta River. (Author's abstract)
W89-05266

CONSUMPTIVE USE OF STREAMFLOW INCREASES IN THE COLORADO RIVER BASIN,
Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.
T. C. Brown, B. L. Harding, and W. B. Lord.
Water Resources Bulletin WARBAQ, Vol. 24, No. 4, p 801-814, August 1988. 2 fig, 6 tab, 27 ref.

Descriptors: *Streamflow, *Water use, *Colorado River, *Hydrologic models, *Vegetation effects, *Forest management, *Flow augmentation, *Forest hydrology, *Water yield improvement, Water allocation, Hydrologic properties, Rivers, Optimization, Simulation, Forest watersheds.

The disposition of streamflow increases that could be created by vegetation management on forest land along the upper reaches of the Colorado River is examined. A network optimization model was used to simulate water flow, storage, consumptive use, and loss within the entire Colorado River Basin with and without the flow increases, according to various scenarios incorporating both current and future consumptive use levels as well as existing and potential institutional constrains. Results indicate that very little of the flow increases would be consumptively used at current use levels, or even at future use levels, if water allocation institutions remain unchanged. Given future use levels and economically based water allocation institutions, up to one-half of the flow increases could be consumptively used. The timing of streamflow increases, and the institutional constraints on water allocation, often limit the potential for consumptive use of flow increases. (Author's abstract)
W89-05270

ESTIMATED CONSUMPTIVE LOSS FROM MAN-MADE SNOW,
Wright Water Engineers, Inc., Denver, CO.
L. M. Eisel, K. D. Mills, and C. F. Leaf.
Water Resources Bulletin WARBAQ, Vol. 24, No. 4, p 815-820, August 1988. 2 fig, 3 tab, 3 ref.

Descriptors: *Water use, *Recreation, *Recreation demand, *Snow skiing, *Model studies, Water loss, Energy, Energy transfer, Colorado, Data collections, Regression analysis, Thermodynamics.

Consumptive loss of water attributable to man-made snowmaking was estimated using an energy balance model and a mass balance procedure. Data from nine field experiments at Colorado ski areas were collected and used in these models. The mean consumptive loss using the energy balance model for the nine experiments was 6.0% and 5.8% for the mass balance model. A thermodynamic relationship and a regression equation were developed to provide a procedure to estimate consumptive loss as a linear function of atmospheric temperature. (Author's abstract)
W89-05271

HYDROGEOLOGY AND GROUND-WATER USE AND QUALITY, BROWN COUNTY, WISCONSIN,
Geological Survey, Madison, WI. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-05391

BALANCING THE NEEDS OF WATER USE,
J. W. Moore.
Springer-Verlag, New York. 1989. 267p.

Descriptors: *Multiobjective planning, *Water use, *Competing use, *Water management, Agriculture, Forestry, Fish, Wildlife, Transportation, Energy, Industrial water, Water storage, Water quality.

An up-to-date review is provided of the multiple uses of water in diverse parts of the world through discussions of the use of water by: agriculture and forestry, fish and wildlife, manufacturing, transportation, water storage, energy generation, and municipalities. The environmental impact created by each of these uses, and their interaction, are reviewed in detail. The book concludes with a treatment of water quality standards, which have emerged as an effective way of balancing the needs of multiple users. (Lantz-PTT)
W89-05426

WESTERN WATER FLOWS TO THE CITIES,
J. A. Folk-Williams, S. C. Fry, and L. Hilgendorf.
Island Press, Washington, DC. 1985. 217 p.

Descriptors: *California, *Colorado, *Nevada, *New Mexico, *Utah, *Arizona, *Texas, *Water law, Case studies, Law enforcement, Decision making, Water use, Legal aspects.

The cities of the Southwest, though responsible for only a small fraction of total water use in the region, are among the most active developers and purchasers of new water supplies. Their decisions about water resource strategies are also increasingly controversial among the urban and rural constituencies most directly affected by their plans. Surveys are presented of disputes and decisional problems relating to water supply in twenty cities and the surrounding urbanizing regions in Arizona, southern California, Colorado, Nevada, New Mexico, western Texas and Utah. Conflict with Indian tribes is especially widespread, and there are also numerous disputes involving agricultural communities, environmental and recreational groups as well as rural counties. Litigation, media and political actions are important alternatives for those constituencies who believe their interests are not adequately represented in decision-making. Thirty-eight of the 56 disputes engaged the interests of constituencies with rural concerns, and litigation was used in 26 of these cases. In 13 of these lawsuits, negotiation has been used as a means of reaching decisions. The extent of conflict surrounding urban water decisions suggests that constituency groups are well enough organized to be able to intervene in many circumstances, though there are enormous differences in the resources available to these groups. Parties to disputes summarized in this study range from small community groups using impromptu fund-raising techniques to finance a lawsuit to governmental agencies with multi-billion dollar budgets. The Overview section provides a brief summary of the study as a whole. The Survey section presents an introduction to the water resources, law and agency structure in each state, followed by the studies of particular cities. There is a water resources profile for each city, summarizing water supply and use, administration, pricing and conservation issues, and this is followed by a section on decision making and dispute resolution, which reviews specific disputes and problems. Negotiated agreements relating to four situations covered in the survey are reprinted in the Documents section, and a bibliography and table of cases are found in the Sources section. The final element of the text is an Index which lists parties to disputes reviewed in the survey. (Lantz-PTT)
W89-05769

ECONOMIC STUDY FOR THE POTENTIAL FOR WATER MARKETS IN IDAHO,
Washington State Univ., Pullman. Dept. of Agricultural Economics.
For primary bibliographic entry see Field 6B.
W89-05777

6E. Water Law and Institutions

DYE TRACING: ITS APPLICATION TO GROUND WATER LAW FOR DEFINING 'SUBTERRANEAN STREAMS' IN KARST TERRANES,
Southwest Texas State Univ., San Marcos.
A. E. Ogden.
IN: Proceedings of the Environmental Problems in Karst Terranes and Their Solutions Conference. National Water Well Association, Dublin, OH. 1986. p 151-162, 8 fig, 16 ref.

Descriptors: *Karst hydrology, *Legal aspects, *Water law, *Groundwater, *Subterranean streams, *Karst, *Tracers, Dyes, Public waters, Sinks, Texas.

The City of Camp Wood, Texas, obtains its water from Old Faithful Spring which emerges from the Glen Rose Limestone. Since the water was considered groundwater, no water-use permit was required. The source of Old Faithful Spring was believed to be sinking water of Camp Wood Creek. When developers planned to place impoundments on Camp Wood Creek, the City became concerned. The sinking stream was then traced to the spring using fluorescein and rhodamine dyes and optical brighteners. The tracer flowed four miles in just twenty-four hours. The hearing examiner and the State's lawyers decided that based on the groundwater traces and the velocity of movement that this water was in a 'well defined subterranean stream' and should be considered as surface water. The City of Camp Wood then was required to obtain a water-use permit. Their prior-use superseded in time and importance the desired use of the developers, thus saving the spring. This could be precedent setting in demonstrating the use of tracers in groundwater law applications. Therefore, other endangered limestone springs in Texas and throughout the eastern USA may be saved through this mechanism. This has further applications for preventing sinkhole development associated with groundwater mining and also for saving rare and endangered species living in cave streams and spring pools. (See also W89-04586) (Author's abstract)
W89-04593

ORDINANCE FOR THE CONTROL OF URBAN DEVELOPMENT IN SINKHOLE AREAS IN THE BLUE GRASS KARST REGION, LEXINGTON, KENTUCKY,
Kentucky Geological Survey, Lexington.
For primary bibliographic entry see Field 4B.
W89-04594

CANADA'S WETLANDS: A NATIONAL WETLANDS CONSERVATION INITIATIVE,
Department of the Environment, Ottawa (Ontario). Lands Conservation Branch.
For primary bibliographic entry see Field 2H.
W89-04690

EPA'S SLUDGE PERMIT PROGRAM,
Environmental Protection Agency, Washington, DC. Office of Water Enforcement and Permits.
For primary bibliographic entry see Field 5E.
W89-04801

RCRA LABORATORY CERTIFICATION,
New Jersey Dept. of Environmental Protection, Trenton. Office of Quality Assurance.
For primary bibliographic entry see Field 6B.
W89-04822

IMPACTS AND INTERFACE OF CERCLA MONITORING REQUIREMENTS WITH OTHER STATE AND FEDERAL PROGRAMS,
New Jersey Dept. of Environmental Protection, Trenton. Office of Quality Assurance.
K. L. Stauber, D. M. Stainken, R. L. Fischer, and R. R. Hirst.
IN: Waste Testing and Quality Assurance. American Society for Testing and Materials, Philadelphia, PA. Special Technical Publication 999, 1988. p 146-151, 2 tab.

Descriptors: *Environmental policy, *Environmental protection, *Administrative regulations, *Interagency cooperation, *Legal aspects, *New Jersey, Quality control, Drinking water, Laboratories, Permits, Performance evaluation, Monitoring.

The New Jersey Department of Environmental Protection is responsible for implementing environmental policy and administering a regulatory structure in accordance with federal and state statutes. The Department's quality assurance program provides a mechanism that enables the Department to administer programs based on reliable monitoring and analytical data. The QA program uses several elements to control QA activities in administering the federal/state NPDES (National Pollutant Discharge Elimination System), Safe Drinking Water Act (SDWA), and RCRA (Resource Conservation and Recovery Act) programs. These elements include the use of a state laboratory certification program, specialized QA permit requirements, use of QA project plans, use of laboratory and field audits, and performance evaluation (PE) samples. (See also W89-04816) (Author's abstract)
W89-04827

EDWARDS AQUIFER. EXTREMELY PRODUCTIVE, BUT.... A SOLE-SOURCE WATER SUPPLY FOR SAN ANTONIO AND SURROUNDING COUNTIES IN SOUTH-CENTRAL TEXAS,
Geological Survey, San Antonio, TX.
For primary bibliographic entry see Field 2F.
W89-04831

OVERVIEW OF ENVIRONMENTAL SANITATION IN RURAL NIGERIA,
Nigerian Inst. of Social and Economic Research, Ibadan.
For primary bibliographic entry see Field 5G.
W89-05337

TAMING B.C. HYDRO: SITE C AND THE IMPLEMENTATION OF THE B.C. UTILITIES COMMISSION ACT,
University of Western Ontario, London. Dept. of Geography.
L. G. Smith.
Environmental Management EMNGDS, Vol. 12, No. 4, p 429-443, July 1988. 2 fig, 25 ref.

Descriptors: *Public policy, *Hydroelectric power, *Hydroelectric plants, *British Columbia, *Canada, *Administrative regulations, Legislation, Legal aspects, Policy making, Resources development.

Public policy making in resources management is greatly influenced by the institutional arrangements that arise out of the legal powers, administrative structures, and financial provisions of the decision system. In British Columbia, the institutional arrangements for energy planning in the province have been greatly altered by the passage of the Utilities Commission Act in 1980. This act redefines the policy implementation process for energy in British Columbia and provides for the regulation of the provinces' power utility, B.C. Hydro. This is the first time that the hitherto autonomous utility has been subject to regulation and the Utilities Commission Act represents a major reform in the institutional arrangement for energy planning in the province. The article evaluates the effectiveness of the 1980 B.C. Utilities Commission Act and assesses the impact of the legislation upon the institutional arrangements for energy planning in the province. The effectiveness of the 1980 B.C. Utilities Commission Act is evaluated, and the impact of the legislation on the institutional arrangements for energy planning in the province is assessed. Data for this article were derived from written sources and a series of personal interviews with key participants involved with energy planning in B.C. The act represented a major departure in the management of energy resources in B.C. Moreover, the implementation of the act's provisions, particularly in regard to B.C. Hydro, had a dramatic impact on the development of new energy projects in the province. While the political and economic climate during the period also favored restraint, the major influence on 'taming' the utility was passage of the Utilities Commission Act. The implications of policy changes that have occurred as a consequence of the act's impact on B.C. Hydro are explored. (Author's abstract)
W89-05342

SMALL RURAL WATER SYSTEMS PROJECT IN THE YEMEN ARAB REPUBLIC; A MID-TERM EVALUATION,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
For primary bibliographic entry see Field 5F.
W89-05373

IRRIGATION MANAGEMENT PROJECT START-UP WORKSHOP IN NEPAL, SEPTEMBER 2 TO 5, 1986,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
For primary bibliographic entry see Field 3F.
W89-05377

GUIDANCE FOR APPLICANTS FOR STATE WELLHEAD PROTECTION PROGRAM ASSISTANCE FUNDS UNDER THE SAFE DRINKING WATER ACT.
Environmental Protection Agency, Washington, DC. Office of Ground-Water Protection.
For primary bibliographic entry see Field 5G.
W89-05401

DEVELOPING A STATE WATER PLAN: GROUND-WATER CONDITIONS IN UTAH, SPRING OF 1983,
Geological Survey, Salt Lake City, UT. Water Resources Div.
For primary bibliographic entry see Field 4B.
W89-05403

CLEAN WATER ACT: UPDATE,
Smith and Schnacke, Dayton, OH.
For primary bibliographic entry see Field 5G.
W89-05509

RESERVED WATER RIGHTS SETTLEMENT MANUAL,
P. W. Sly.
Island Press, Washington, DC. 1988. 259p.

Descriptors: *Reservation doctrine, *Water rights, *Water law, Legal aspects, Competing water use, Treaties, State jurisdiction, Federal jurisdiction, Handbooks.

Indian and other federal reservations have come into increasing conflict with state water right systems based on current interpretations of 19th century treaty provisions. The federal system of water rights was created by federal courts to protect water rights on federal reservations. At the same time state water rights provided the basis of Western urban and agricultural development. As the two systems evolved, the conflicts between the two have often resulted in expensive and lengthy litigation. The Conference of Western Attorneys General, in an attempt to assist in settlement efforts as an alternative to litigation, has developed this manual which looks at the best approaches to settlement. Examining the negotiation process itself and the roles played by the participants, this manual helps provide the tools for the settlement agreements. (Lantz-PTT)
W89-05753

WATER LAW,
Cook Coll., New Brunswick, NJ.
W. Goldfarb.
Lewis Publishers, Chelsea, Michigan. 1988. 284p.

Descriptors: *Legal aspects, *Water law, Decision making, Water resources management, Water quality control, Water use, Competing use, Water treatment, Resource allocation.

Law is a critical framework for all water resources decision making. State engineers allocate water based on their state's law of water diversion and distribution. Water quality scientists perform research according to priorities established by law. Planners develop water plans and evaluate proposed projects affecting water resources in the context of federal, state, and local law. Corporate executives order water pollution control equipment to meet requirements contained in their discharge permits. Whether they realize it or not, all professionals, citizen activists, students concerned with water resources--be they in the public sector, private sector, academia, or consulting firms--would be more effective if they possessed a fundamental knowledge of water law. This book is primarily intended for nonlawyers, and discusses the topic of water law through four key parts: (I) the law of water diversion and distribution; (II) water resources development and protection; (III) nontransformational uses--uses that do not change the waterbody; and (IV) water treatment and land use. (Lantz-PTT)
W89-05756

GROUNDWATER QUALITY: STATE ACTIVITIES TO GUARD AGAINST CONTAMINANTS.
General Accounting Office, Washington, DC.
For primary bibliographic entry see Field 5G.
W89-05765

ENVIRONMENTAL POLICY IN BRITAIN: REAFFIRMATION OR REFORM,
Imperial Coll. of Science and Technology, London (England).
R. Macrory.
Available from the National Technical Information Service, Springfield, VA 22161, as DE88-751950. Price codes: A04 in paper copy, A01 in microfiche. Report No. IIUG/dp--86-4, (1986). 46p, 2 fig, 34 ref.

Descriptors: *Environmental policy, *Environmental protection, *Great Britain, *Public policy, *Management planning, Legal aspects, Agriculture, Environmental control, Administration, Legislation.

Britain's geographical characteristics and common law traditions have given rise to environmental laws and policies which display particular national characteristics, notably a gradualist and decentralized approach. Very real achievements in many areas of environmental control over the past 100 years have, however, resulted in a degree of administrative compliency, and an exaggerated support for the status quo in policy discussions, particularly at an international level. The changing shape of nationfl politics together with Britain's apparent isolated position in the international community on a number of environmental issues have combined to give rise to pressures for radical rethinking in admininstrative circles on the efficacy of long-established practices. Key policy shifts that

have already taken place, notably relating to agriculture, are considered, and it is suggested that there will be an increasing move toward centralism in policy design. The results of current developments may well give rise to important changes in legislative and administrative approaches, that have hitherto been seen as an essential feature of British environmental policy. (Lantz-PTT)
W89-05767

WESTERN WATER FLOWS TO THE CITIES,
For primary bibliographic entry see Field 6D.
W89-05769

OUR NATIONAL HERITAGE: A PROTECTION GUIDEBOOK,
J. A. Kusler, C. C. Harwood, and R. B. Newton.
Environmental Law Institute, Washington, DC. 1983. 167p.

Descriptors: *Conservation, *Wetlands, *Regulations, *Environmental protection, Decision making, Public policy, Federal government, State government, Local governments, Legal aspects, Literature review.

This guidebook is for local governments, conservation organizations, landowners and others interested in the protection of wetlands through local action. It reflects a careful literature review, an examination of State wetland statutes and programs, a survey of local wetland protection programs, an examination of all reported wetland cases, the papers presented at the first National Wetland Symposium in 1977, and many interviews with scientists, lawyers, engineers and others. Chapters 1 and 2 discuss the need to protect and manage wetlands, threats to wetlands, and wetland origins and characteristics. Chapters 3, 4 and 5 identify management principles and standards, wetland protection techniques, and procedures for evaluation of development proposals. Chapters 6, 7 and 8 consider Federal, State and local regulatory efforts. Chapter 9 addresses legal issues in wetland regulation. Chapters 10 and 11 consider nonregulatory management techniques and the role of the private sector in wetland protection. The Appendices include a draft wetland protection ordinance, examples of wetland protection ordinances, a guide to federal programs which affect wetlands, a list of endangered animal species dependent on wetlands, and examples of deed restrictions. (Lantz-PTT)
W89-05770

6F. Nonstructural Alternatives

POTENTIAL EMISSIONS REDUCTIONS FROM CONSERVATION, LOAD MANAGEMENT, AND ALTERNATIVE POWER,
For primary bibliographic entry see Field 5G.
W89-04869

6G. Ecologic Impact Of Water Development

SINKHOLE INVESTIGATION: SOUTH-CENTRAL PENNSYLVANIA,
Buchart-Horn, Inc., York, PA.
For primary bibliographic entry see Field 2F.
W89-04602

HYDROGEOLOGIC IMPACT ASSESSMENT OF PROPOSED URBANIZATION ATOP A KARST AQUIFER,
NUS Corp., Houston, TX.
For primary bibliographic entry see Field 4C.
W89-04609

REELFOOT LAKE. AN ASSESSMENT FOR WATER LEVEL MANAGEMENT.
Tennessee Wildlife Resources Agency, Nashville.
For primary bibliographic entry see Field 2H.
W89-04662

PROCEEDINGS OF THE INTERNATIONAL SYMPOSIUM ON THE HYDROLOGY OF WETLANDS IN TEMPERATE AND COLD REGIONS.
For primary bibliographic entry see Field 2H.
W89-04689

TEMPERATURE CHANGES IN THE SOIL AND CLOSE TO THE GROUND ON WETLANDS DRAINED FOR FORESTRY,
Joensuu Univ. (Finland). Dept. of Biology.
For primary bibliographic entry see Field 2H.
W89-04697

EFFECT OF DRAINAGE ON THE TEMPERATURE OF SURFACE PEAT,
Joensuu Univ. (Finland). Dept. of Forestry.
For primary bibliographic entry see Field 2H.
W89-04699

THEORETICAL AND PRACTICAL ASPECTS OF INCREASING DRAINED PEATLAND LIFETIME,
Belorusskii Nauchno-Issledovatelskii Inst. Melioratsii i Vodnogo Khozyaistva, Minsk.
For primary bibliographic entry see Field 4C.
W89-04705

GENERAL DESCRIPTION OF THE NURMES-STUDY,
North Karelian Water District Office, Joensuu (Finland).
For primary bibliographic entry see Field 4C.
W89-04706

EFFECTS OF CLEAR-CUTTING AND FORESTRY DRAINAGE ON RUNOFF IN THE NURMES-STUDY,
National Board of Waters, Helsinki (Finland). Water Research Inst.
For primary bibliographic entry see Field 4C.
W89-04707

PROCEEDINGS OF THE INTERNATIONAL SYMPOSIUM ON THE HYDROLOGY OF WETLANDS IN TEMPERATE AND COLD REGIONS.
For primary bibliographic entry see Field 2H.
W89-04731

OPTIMIZATION OF THE MICROCLIMATE OF BOG GEOSYSTEMS,
Akademiya Navuk BSSR, Minsk. Faculty of Geography.
For primary bibliographic entry see Field 2H.
W89-04735

ALTERATION OF HYDROLOGICAL-ECOLOGICAL LINKAGES IN WETLAND SOILS: AN EXAMPLE OF PEDOGENIC DEFLECTION ON EXMOOR, U.K.,
Exeter Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 2H.
W89-04736

HYDROLOGY OF WETLANDS AND MAN'S INFLUENCE ON IT,
North Central Forest Experiment Station, Grand Rapids, MN. Forestry Sciences Lab.
For primary bibliographic entry see Field 2H.
W89-04738

DRAINAGE EFFECT ON THE ENVIRONMENT,
Gosudarstvennyi Gidrologicheskii Inst., Leningrad (USSR).
For primary bibliographic entry see Field 2H.
W89-04740

IMPACTS OF WATER LEVELS ON BREEDING CANADA GEESE AND METHODS FOR MITIGATION AND MANAGEMENT IN THE SOUTHERN FLATHEAD VALLEY, MONTANA,
Confederated Salish and Kootenai Tribes of the Flathead Reservation, Pablo, MT.
D. L. Mackey, S. K. Gregory, W. C. Matthews, J. J. Clear, and I. J. Ball.
Available from the National Technical Information Service, Springfield, VA 22161, as DE88-003962. Price codes: A06 in paper copy, A01 in microfiche. Report No. DOE/BP/10062--3, November 1987. 162p, 10 fig, 49 tab, 121 ref, append.

Descriptors: *Reservoir operation, *Wildlife habitats, *Water level, *Water management, *Ecological effects, *Geese, *Montana, Hydroelectric plants, Kerr Dam, Mortality, Population dynamics, Flathead Lake, Water management.

Kerr Hydroelectric Dam is located at the south end of Flathead Lake, controls water levels on the lake and the Flathead River below the dam, and is currently operated as a load control facility. Dam operations, and subsequent water levels, are primarily affected by electric power production, recreational constraints on lake levels, and operation of Hungry Horse Dam located on the South Fork of the Flathead River. Current operation of Kerr Dam creates the greatest yearly water level fluctuations on both the lake and river during the Canada goose brood and nesting period. Data collected from 1980-82 indicated that goose nest numbers on the river were lower than during the 1950's, and that brood habitat on the lake may be limiting the goose population there. The study was conducted from 1983-87 to determine the effects of Kerr Dam operation on Canada goose populations and habitat on the south half of Flathead Lake and the Flathead River, and to formulate management and mitigation recommendations. Nesting geese on the river appeared to be negatively affected by a lack of nest sites free from predators, and responded to available artificial nest structures with an increase in nest numbers and nesting success. Under current dam operation, river channel depths and widths do not discourage access to nesting islands by mammalian predators during some years and high predation on ground nests occurs. Ground nesting geese on the river used sites on small islands or along the edge of large islands, with abundant cover surrounding the nest. Brood habitat on the lake was lower in quality and quantity than on the river due to dam operations. Gosling mortality on the lake was high; almost 2X higher than on the river. Losses of brood habitat in the form of wet meadow marshes were documented and mitigation options developed. Management/mitigation alternatives and monitoring methods for nesting and brooding geese were identified. (Lantz-PTT)
W89-04878

EFFECTS OF DETENTION ON WATER QUALITY OF TWO STORMWATER DETENTION PONDS RECEIVING HIGHWAY SURFACE RUNOFF IN JACKSONVILLE, FLORIDA,
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 5G.
W89-04929

THICKNESS AND HYDROGEOLOGY OF AQUIFERS AND CONFINING UNITS BELOW THE UPPER GLACIAL AQUIFER ON LONG ISLAND, NEW YORK,
Geological Survey, Syosset, NY. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-04945

MIDWEST (U.S.A.) RESERVOIR WATER QUALITY MODIFICATION: I. PARTICULATE PARAMETERS,
Iowa Dept. of Natural Resources, Des Moines.
For primary bibliographic entry see Field 5C.
W89-04974

MIDWEST (U.S.A.) RESERVOIR WATER QUALITY MODIFICATION: II. OXYGEN-DEMANDING PARAMETERS,
Iowa Dept. of Natural Resources, Des Moines.
For primary bibliographic entry see Field 5G.
W89-04975

MIDWEST (U.S.A.) RESERVOIR WATER QUALITY MODIFICATION: III. SOLUBLE NUTRIENTS,
Iowa Dept. of Natural Resources, Des Moines.
V. I. Okereke, E. R. Baumann, T. A. Austin, and D. S. Lutz.
Water, Air, and Soil Pollution WAPLAC, Vol. 37, No. 3-4 p 343-354, February 1988. 2 fig, 1 tab, 27 ref.

Descriptors: *Water quality, *Reservoirs, *Orthophosphates, *Nutrients, *Dam effects, *Nitrogen, Water sampling, Nitrates, Nitrites, Iowa, Flood-control storage, Dam effects, Annual runoff, Pollution load, Correlation analysis.

An analysis of the impact of a flood control reservoir on the downstream concentrations and loadings of nitrite plus nitrate N and orthophosphate (soluble nutrients) are presented. Fifteen years of weekly sampling data (9 years before impoundment and 6 years after impoundment) from four sampling stations were analyzed. The results indicate an increase in the annual concentrations of nitrite plus nitrate N. These increases varied from 4% to 34%. The changes in orthophosphate concentrations were more modest. Annual loading rates of both parameters (kg per ha per year) correlated well with runoff (cm per year). A comparison of the leading rate correlations for all four sampling stations showed that the differences between them are not significant at the 95% level of confidence. Besides, the reservoir was shown to have had no significant impact on the average annual loading rates of these two soluble parameters at downstream locations. (See W89-04974 and W89-04975) (Author's abstract)
W89-04976

EFFECTS OF WEED CONTROL ON SPECIES COMPOSITION OF AQUATIC PLANTS AND BANK PLANTS AND MACROFAUNA IN DITCHES,
Utrecht Rijksuniversiteit (Netherlands). Dept. of Plant Ecology.
For primary bibliographic entry see Field 4A.
W89-05041

SCOPE OF MISSION-ORIENTATION IN DUTCH FRESHWATER ECOLOGY,
Amsterdam Univ. (Netherlands). Dept. of Science Dynamics.
J. Cramer.
Hydrobiological Bulletin HYBUD9, Vol. 21, No. 2, p 223-234, December 1987. 1 fig, 31 ref.

Descriptors: *Limnology, *Freshwater ecology, *The Netherlands, Theoretical analysis, Reviews.

In response to growing concern about environmental problems ecologists have engaged in a variety of 'mission-oriented' efforts in which they claim to have taken into account the objective of helping to solve environmental problems in their research strategies or research programs. The significance of these efforts is evaluated here in terms of both the theoretical development of the field of ecology and its orientation towards social objectives. Three examples of mission-orientation are analyzed on the basis of a case study of Dutch freshwater ecology: (1) ecosystems research within the framework of the International Biological Program; (2) landscape ecology, and (3) ecological research on the management of freshwater resources. These examples demonstrate that in principle the scope of mission-orientation in ecology can be broad. In Dutch freshwater ecology, however, two specific approaches have become particularly institutionalized. The ecologists tended to opt either for theory-centered approaches close to the type of research carried by ecologists developing the field regardless of any societal mission, or for problem-centered approaches without much emphasis on theory development. Types of mission-orientation which can be placed between these extremes have been established only to a limited extent in Dutch freshwater ecology. (Author's abstract)
W89-05045

LIMNOLOGICAL CHARACTERISTICS OF LAKE OF THE OZARKS, MISSOURI II: MEASUREMENTS FOLLOWING FORMATION OF A LARGE RESERVOIR UPSTREAM,
Missouri Univ.-Columbia. School of Forestry, Fisheries and Wildlife.
For primary bibliographic entry see Field 2H.
W89-05185

INTER-RESERVOIR INTERACTIONS: EFFECTS OF A NEW RESERVOIR ON ORGANIC MATTER PRODUCTION AND PROCESSING IN A MULTIPLE-IMPOUNDMENT SERIES,
Oak Ridge National Lab., TN. Environmental Sciences Div.
For primary bibliographic entry see Field 2H.
W89-05186

BACTERIAL DENSITIES IN SELECTED SESTON FRACTIONS IN A LARGE RIVER ECOSYSTEM,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Biology.
For primary bibliographic entry see Field 2H.
W89-05187

SMALL WATER BODIES AND WETLANDS: THE INFLUENCE OF WATER LEVEL MANIPULATION ON METAPHYTON PRODUCTION IN A TEMPERATE FRESHWATER MARSH,
Delta Waterfowl and Wetlands Research Station, Portage la Prairie (Manitoba).
S. E. Gurney, and G. G. C. Robinson.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IVTLAP, Vol 23. No. 2, p 1032-1040. August 1988. 4 fig, 3 tab, 29 ref.

Descriptors: *Environmental effects, *Limnology, *Light intensity, *Marshes, *Productivity, *Phytoplankton, Metaphyton, Marsh Ecology Research Program, Manitoba, Canada, Water level, Macrophytes.

In response to the need to broaden the understanding of the mechanisms responsible for controlling freshwater marsh productivity, a research project has been undertaken at the Delta Waterfowl and Wetlands Research Station, Delta, Manitoba, Canada. This Marsh Ecology Research Program (MERP), initiated in 1979, is designed as a long term experimental study evaluating the effects of water level management on the floristic and faunistic composition of freshwater marshes. Metaphyton and phytoplankton were collected from the ten experimental cells in the MERP complex. Metaphyton productivity was estimated on four occasions. Phytoplankton productivity was also estimated on four dates. Primary productivity experiments were conducted in a water filled incubator which allowed replication of a range of light intensities. There exists a significant negative correlation between macrophyte density and metaphyton cover. The partial correlation analyses indicate that the relationship between these two parameters is somewhat stronger in the low water level treatments. Although metaphyton productivity saturated at a lower light intensity, metaphytic algae appear to be less efficient when compared to phytoplankton. (Davis-PTT)
W89-05192

LAKE OF VIRELLES (PROV. HAINAUT, BELGIUM): MANAGEMENT OF A LAKE FOR NATURE CONSERVATION AND RECREATION,
Vrije Univ., Brussels (Belgium). Lab. voor Algemene Plantkunde en Natuurbeheer.
J. J. Symoens, M. DeClercq, R. A. Osafo, and U. Sansen.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IVTLAP, Vol. 23, No. 2, p 1057-1062, August 1988. 1 fig, 19 ref.

Descriptors: *Limnology, *Lake management, *Water quality control, *Conservation, *Recreation, Ecosystems, Virelles, Belgium, Eutrophic lakes, Aves, World Wildlife Fund, Wastewater pollution, Water birds, Water level, Fish, Species diveristy.

The lake of Virelles lies about 3 km NE of Chimay, Belgium. The lake is shallow and shows no stratification. The lake has become a popular recreational site, which has contributed to a deterioration in water quality and biocoenotic diversity. Chemical analyses were performed on monthly lake water samples. The highest mineral content was observed in August and September; the lowest in January. The western tributaries drain mainly low meadows; the most southern of them bring some sewage from a few houses and farms to the lake. The phytoplankton communities are typical of eutrophic water. The lake was known among botanists for its rich flora and diverse vegetation. Of particular interest were the plants of the periodically exposed shores. These vegetation types disappeared, due to the stabilization of the water level for tourism and sport. The ichythyofauna of Virelles comprise mainly pike, roach, tench, bream, carp, eel, and perch. The lake of Virelles is also reputed for its avifauna. Among the species breeding at the lake are the great crested grebe, the teal, the marsh harrier, the water rail, and the kingfisher. In 1983, three conservation organizations established the site of the lake and its surroundings as a nature reserve. The lake has been dried in September 1986 and will be filled again in March 1987. Its level will be lowered in summer and early autumn as it was formerly. The shore slopes are to remain gentle and will not be recut. No sewage from the houses or the farms should reach the lake. Some macrophytic species will be reintroduced to the lake. A controlled use of the lake for sport will be allowed. (Davis-PTT)
W89-05194

LOUISIANA WETLAND LOSS: A REGIONAL WATER MANAGEMENT APPROACH TO THE PROBLEM,
Louisiana State Univ., Baton Rouge. Inst. for Environmental Studies.
For primary bibliographic entry see Field 2L.
W89-05338

ARCHAEOLOGICAL INVESTIGATIONS AT THE BONAPARTE PUMPING STATION NEAR TONASKET, OKANOGAN COUNTY, WASHINGTON,
Washington State Univ., Pullman. Center for Northwest Anthropology.
J. A. Draper.
Contributions in Cultural Resource Management No. 24, June 1988. 20p, 8 fig, 1 tab, 10 ref.

Descriptors: *Archaeology, *Pumping plants, *Washington, Tonasket, Social aspects, History.

In March in 1988, archaeologists from the Center for Northwest Anthropology, Washington State University, conducted a class III cultural resources survey of the Bonaparte Pumping Plant prior to the construction of a sediment pound and other related ground disturbing activities. Twenty-six 50 X 50 X 50 cm shovel test units (3.25 sq m) and six trenches (331.1 cu m) were excavated to determine whether prehistoric cultural material, human remains, or other features were present. Both excavation techniques failed to yield evidence of prehistoric residues. The absence of cultural material is attributed to the location of the pumping plant on an active floodplain. (Author's abstract)
W89-05422

UNITED NATIONS ENVIRONMENTAL PROGRAMME: ENVIRONMENTAL DATA REPORT.
Monitoring and Assessment Research Centre, London (England).

For primary bibliographic entry see Field 5B.
W89-05512

BENTHIC FAUNAL COLONIZATION OF AN OFFSHORE BORROW PIT IN SOUTHEASTERN FLORIDA,
Florida Atlantic Univ., Boca Raton. Coll. of Science.
For primary bibliographic entry see Field 2L.
W89-05752

OIL SHALE, WATER RESOURCES, VALUABLE MINERALS OF THE PICEANCE BASIN, COLORADO: THE CHALLENGE AND CHOICES OF DEVELOPMENT,
Geological Survey, Lakewood, CO. Water Resources Div.
For primary bibliographic entry see Field 4C.
W89-05776

7. RESOURCES DATA

7A. Network Design

CONSIDERATIONS IN THE DEVELOPMENT OF A PROPOSED MONITORING AND TESTING PROGRAM TO ASSESS THE IMPACT OF SUBSURFACE WASTE INJECTION,
INTERA Technologies Ltd., Ottawa (Ontario). Hydrogeology Group.
R. B. Whiffin, D. W. Belanger, R. P. Scroggins, and K. G. Raven.
IN: Hydrogeology of Sedimentary Basins: Application to Exploration and Exploitation. National Water Well Association, Dublin, OH. 1986. p 258-268, 5 fig, 2 tab, 15 ref.

Descriptors: *Underground waste disposal, *Network design, *Injection wells, *Oil fields, *Geohydrology, Wastewater, Hydraulics, Sedimentary basins, Data collection, Surface water, Groundwater movement, Chemical properties.

A hydrogeologic testing and monitoring program has been developed that is suitable for use in deep sedimentary basins such as the heavy oil areas of Alberta. Primarily hydrogeological and geochemical information used to characterize the groundwater flow system was examined. The program was developed around oil field hydraulic testing techniques such as drillstem, pulse and slug tests to obtain hydraulic conductivity/permeability and formation pressure/hydraulic head data. The hydraulic test program incorporated testing methodologies in low and high permeability geologic media. Measurement scale, equipment compliance, borehole history, temperature, and fluid properties also were considered. Representative samples of deep formation fluids or injection waste were obtained, without dilution or contamination caused by drilling fluids or the sampling technique, by using proven techniques such as drill water tracers, packer-isolated test intervals and downhole sample collection. The samples are suitable for analysis of inorganic and organic parameters, environmental isotopes and formation gases. Well completion alternatives were assessed for their suitability for long-term pressure monitoring and fluid sample acquisition, including the use of multizone completions in a single borehole. The effects of well-bore storage, purge volume requirements, equipment reliability, performance and ease of operation were considered in selecting monitoring equipment. (See also W89-04565) (Author's abstract)
W89-04585

COMPREHENSIVE SAMPLING PROGRAM FOR THE Y-12 PLANT AREA SOURCE POLLUTION ASSESSMENT AND CONTROL PLAN,
Oak Ridge Y-12 Plant, TN.
For primary bibliographic entry see Field 5B.
W89-04745

ROLE OF QUALITY ASSURANCE IN FUTURE EPA AUDITS,
Environmental Protection Agency, Athens, GA.
M. H. Birch.
IN: Analytical Techniques and Residuals Management in Water Pollution Control Specialty Conference April 19-20, 1988. Water Pollution Control Federation, Alexandria, VA 22314-1994. p 74-79.

Descriptors: *Environmental Protection Agency, *Performance evaluation, *Water analysis, *Environmental Protection Agency Audits, *Quality control, *Enforcement, Quality control, Data acquisition, Standards, Quality assurance.

An integral part of EPA's compliance inspection process is the evaluation of the permittee's laboratory and quality assurance (QA) program to determine whether approved procedures are followed and the data are reported according to permit requirements. A QA plan has two components: a QA program and quality control (QC) procedures. QA refers to the total program and is required for all functions bearing environmentally related measurements. This includes activities such as: project/study plans; sample collection; laboratory analysis; data validation, analysis, reduction, and reporting; documentation; and data storage. QC focuses on the detailed technical activities (calibrations, duplicates, spikes, monitoring of temperature regulated devices, etc.) needed to achieve a specified data quality and is implemented at the field/bench level. EPA criteria for evaluating the QA programs of permittee laboratories cover several points; among these are laboratory qualifications, laboratory performance evaluation standards, sample matrix effects, and documentation. The trend is toward stricter guidance to help data reviewers determine the reliability and usability of the data. Once the guidance is in place there is an excellent probability that it will be mandated by EPA. (See also W89-04782) (Rochester-PTT)
W89-04790

APPLICATION OF COMPUTERIZED QUALITY CONTROL CHARTS AND REPORTS FOR WASTEWATER FACILITIES,
Data Stream Systems, Greenville, SC.
For primary bibliographic entry see Field 5D.
W89-04791

GUIDELINES FOR MEASURING THE PHYSICAL, CHEMICAL, AND BIOLOGICAL CONDITION OF WILDERNESS ECOSYSTEMS,
Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.
D. G. Fox, J. C. Bernabo, and B. Hood.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-160841. Price codes: A03 in paper copy, A01 in microfiche. General Technical Report RM-146, November 1987. 48p, 12 fig, 20 tab, 128 ref.

Descriptors: *Environmental quality, *Water quality, *Monitoring, *Data acquisition, *Network design, *Ecosystems, *Wilderness areas, Chemical analysis, Biological studies, Physical analysis, Aquatic environment, Vegetation, Atmosphere, Soil properties.

There are several important reasons for systematically establishing guidelines for methods and techniques for monitoring current air quality related value (AQRV) conditions and tracking future condition changes. These reasons include the following: To provide clarity internally for the Forest Service in Wilderness management, planning, operations, and decision, and externally to States and prospective new air pollution sources about what the FLM considers necessary in monitoring the current condition of certain AQRVs and potential air pollution-caused changes in those AQRVs; and to provide a standardized approach to AQRV impact analysis so that analyses by different parties can be compared, and so that analyses in different permitting cases can be compared with one another. The scientists and contributors that developed this document (listed at the end of these Guidelines) were divided into six work groups, with the Work Group Leaders responsible for the development of protocols for the five technical areas: (1) Atmospheric Environment; (2) Soils and Geology; (3) Aquatic Chemistry and Biology; (4) Vegetation; and (5) Regulatory and Management Constraints. A sixth group, Government Applications, was added shortly after the project began. The first section of this document presents the paper prepared by Work Group 5, Regulatory and Management Constraints. The following sections present each set of protocols developed by Work Groups 1 through 4. (Lantz-PTT)
W89-04881

REVIEW OF THE HYDROLOGIC DATA-COLLECTION NETWORK IN THE ST. JOSEPH RIVER BASIN, INDIANA,
Geological Survey, Indianapolis, IN. Water Resources Div.
For primary bibliographic entry see Field 7B.
W89-04931

DISCRIMINATION AMONG ONE-DIMENSIONAL MODELS OF SOLUTE TRANSPORT IN POROUS MEDIA: IMPLICATIONS FOR SAMPLING DESIGN,
Geological Survey, Reston, VA.
For primary bibliographic entry see Field 5B.
W89-05056

DECISION SUPPORT SYSTEM FOR SELECTING INPUTS TO A BASIN SCALE MODEL,
Agricultural Research Service, Temple, TX. Soil and Water Conservation Research Div.
J. G. Arnold, and N. B. Sammons.
Water Resources Bulletin WARBAQ, Vol. 24, No. 4, p 749-759, August 1988. 5 fig, 4 tab, 28 ref, append.

Descriptors: *Network design, *Mathematical models, *Model studies, *Data acquisition, *Hydrologic models, *Technology transfer, *Data storage and retrieval, *Decision making, *Water management, Surface water, Planning, Catchment areas, Watersheds, Data collections.

Common constraints in using existing mathematical models are the lack of appropriate input data and inadequate time and money to perform the modeling. A decision support system was developed to aid in selecting inputs to a basin scale soil and water resources model. The system prompts users for input values and formats them in the model input file. The system also accesses large data bases, interfaces with expert systems, gives explanations, suggests default values, and provides graphics. Technology transfer will be enhanced by decreasing the time and money spent during model use and increasing user confidence in the model. (Author's abstract)
W89-05265

GOALS AND DATA COLLECTION DESIGNS FOR WATER QUALITY MONITORING,
Inland Waters Directorate, Vancouver (British Columbia). Monitoring and Agreements Div.
P. H. Whitfield.
Water Resources Bulletin WARBAQ, Vol. 24, No. 4, p 775-780, August 1988. 41 ref.

Descriptors: *Network design, *Water quality, *Monitoring, *Data acquisition, *Project planning, Water quality management, Administrative agencies, Water quality standards, Information systems.

Water quality monitoring cannot address every information need through one data collection procedure. The goals and related procedures for designing water quality monitoring programs are discussed. The discussion focuses on the broad information needs of those agencies operating water quality networks. These information needs include the ability to assess trends and environmental impacts, determine compliance with objectives or standards, estimate mass transport, and perform general surveillance. Each of these information needs has different data requirements. A strategy to develop a sampling procedure at a monitoring site is as follows: (1) establish monitoring goal; (2) select appropriate sampling plan; (3) periodically review data to evaluate adequacy of the sampling plan; and (4) revise sampling as possible. (Freemann-PTT)

W89-05267

STREAM CHEMISTRY IN THE SOUTHERN BLUE RIDGE: FEASIBILITY OF A REGIONAL SYNOPTIC SAMPLING APPROACH,
Environmental Protection Agency, Research Triangle Park, NC.
J. J. Messer, C. W. Ariss, J. R. Baker, S. K. Drouse, and K. N. Eshleman.
Water Resources Bulletin WARBAQ, Vol. 24, No. 4, p 821-829, August 1988. 6 fig, 2 tab, 21 ref. U.S. DOE Contract No. DE-AC05-840R21400.

Descriptors: *Network design, *Data acquisition, *Water pollution sources, *Streams, *Hydrogen ion concentration, *Acid rain, *Feasibility studies, *Stream pollution, *Synoptic Analysis, Project planning, Acidic water, Seasonal variation, Chemical properties, Nitrates, Sulfates.

A pilot study, which was conducted in the Southern Blue Ridge geographical province of the Southwestern U.S., demonstrated the feasibility of a probability-based regional synoptic design for the National Stream Survey, which is a project aimed at estimating the number and percentage of streams in various regions of the U.S. that are acidic or at risk from acid deposition. Estimated population distributions for key chemical variables were not appreciably affected by week-to-week variability in stream chemistry during the spring index period chosen for the study. Differences were observed in estimated acid neutralizing capacity (ANC), nitrate, and pH frequency distributions between spring and summer. Observations made at the downstream node did not represent the chemistry of the entire reach for some variables (ANC and nitrate) as indicated by differences in chemical concentrations between upstream and downstream sampling locations. Coefficients of variation in chemical species were low enough to provide a reasonably stable classification of streams based on ANC. Although median ANC, sulfate, and nitrate concentrations were quite low in the region, the probability of finding streams with pH < 6.3 is less than 1.3% at the alpha $= 0.05$ confidence level. (Author's abstract)
W89-05272

MANAGEMENT AND VALUATION OF AN ENVIRONMENTALLY SENSITIVE AREA: NORFOLK BROADLAND, ENGLAND, CASE STUDY,
University of East Anglia, Norwich (England). School of Environmental Sciences.
R. K. Turner, and J. Brooke.
Environmental Management EMNGDC, Vol. 12, No. 2, p 193-207, March 1988. 6 fig, 4 tab, 36 ref.

Descriptors: *Wetlands, *Environmental protection, *Flood control, *Flood plains, *Water management, *Resources management, Case studies, Economic aspects, Long-term planning, England, Legislation.

Wetlands, like any other environmentally sensitive resource, require very careful evaluation. While it is accepted that all wetlands may be equally valuable in terms of maintaining global life-support systems, individual areas may be ranked according to their uniqueness or the irreplaceability of the resource should the wetland be developed. The various techniques available for evaluating the wetland resource in the development versus conservation conflict situation are critically assessed. Indirect appraisal via the opportunity cost method can generate valuable data that have contributed to the mitigation of such conflict situations. The Broadland, in Norfolk, England, recently designated an environmentally sensitive area (ESA), provides a case study example of wetland management. The search for an 'acceptable' flood alleviation strategy for the ESA is examined in detail. The economic and environmental asset structure of the study area is examined at two levels. A basic 'screening' system is applied to each of the identified flood protection planning units to enable the rank ordering of the units. A more detailed appraisal is then made of the value of selected units so that the cost-effectiveness of any planned expenditure on flood protection works can be assessed. Specific management issues and their likely effect on the environment, in terms of land use for example, are also addressed. The 1986 Agriculture Act marks a potential watershed in British conservation policy. The ESA policy encompasses a dual management strategy that attempts to stimulate compatible agricultural and conservation practices and activities. Other countries that still retain significant unspoiled wetland resources may find that preemptive regulatory government intervention in favor of conservation would help to avoid the worst aspects of the British experience. (Author's abstract)
W89-05339

PROGRAM FOR MONITORING THE CHEMICAL QUALITY OF GROUND WATER IN UTAH--SUMMARY OF DATA COLLECTED THROUGH 1984,
Geological Survey, Salt Lake City, UT. Water Resources Div.
D. Price, and T. Arnow.
Utah Department of Natural Resources Technical Publication No. 88, 1986. 119p, 38 fig, 38 tab, 40 ref.

Descriptors: *Network design, *Water quality, *Groundwater quality, *Monitoring, *Utah, *Hydrologic data collections, Data collections, Water quality control, Chemical analysis, Dissolved salinity, Groundwater level, Groundwater irrigation, Groundwater mining, Chlorides, Sulfates.

The U.S. Geological Survey formally started a program for monitoring groundwater quality in Utah during 1957 in cooperation with the Utah. Most observation wells in the monitoring network are privately owned. Initially, the network consisted of fewer than 50 wells; by 1984, however, it had expanded to include more than 200 wells. Chemical analyses are available for water from some of the wells from as early as 1927, long before those wells were formally added to the network. The monitoring program was initiated to detect any changes in chemical quality that might be associated with the withdrawal of water from wells. Dissolved-solids concentrations in water samples collected from the observation wells through 1984 ranged from 92 to 19,000 mg/L. An observation well in the Uinta Basin yielded the sample with the smallest dissolved solids concentration, and another well in the Uinta Basin yielded the sample with the largest dissolved solids concentration. There was a progressive increase in salinity of water produced by several of the observation wells in Pahvant Valley and in the Milford and Beryl-Enterprise areas. The increases in salinity occurred during 1950-84, coinciding with the decline of water levels due to pumping for irrigation. Water quality changes related either to groundwater withdrawals or groundwater recharge also were detected in several other areas, including Curlew Valley, Cedar City Valley, Northern Utah Valley, the lower Bear River Valley, and the Sevier Desert. Water produced from wells in Goshen Valley and the upper Fremont River valley had short term increases in chloride, sulfate, and dissolved solids concentrations, indicating possible local contamination of the groundwater. Also, since the late 1950's, dissolved solids concentrations have increased in water produced by a well completed in the principal aquifer in Salt Lake Valley downgradient from areas where extensive use has been made of road salt. (Author's abstract)
W89-05413

GATHERING OF DATA FOR MODELLING,
Danmarks Geologiske Undersoegelse, Copenhagen.
L. J. Andersen.
IN: Groundwater Flow and Quality Modelling. D. Reidel Publishing Co., Boston. 1988. p 777-783, 9 ref.

Descriptors: *Model studies, *Network design, *Hydrologic data collections, *Hydrologic models, *Data acquisition, Geohydrology, Field tests, Boreholes, Hydraulic data, Permeability, Conductivity, Regional analysis, Subsurface mapping, Well data, Geologic fissures, Plumes, Denmark.

Gathering of data for modeling is necessary for construction and calibration of the model. The density of data depends on the scale of the Representative Elementary Volume of the modeled geological formation. For large scale, regional models existing data in national data banks may be used. For local, detailed models new data may be collected in the field. A procedure of mapping borehole data in a 3-dimensional form results in a basic data map containing practically all information from well records, i.e., depth of well, lithology of penetrated sequence, water-bearing formations, screened intervals, water level, yield of well and drawdown, completion of well, dimensions of casing and screen, etc. All data are displayed in a cyclogram for each well or borehole in such a way that all the various cyclograms are comparable and all layers and water tables related to a datum. In Denmark a combined drilling, testing, and sampling method has been introduced and successfully used for data collection and localization of pollutant plumes from unconsolidated shallow formations, such as land fills and sites with chemical wastes. For low-permeability fissured formations a new test method called the labeled Slug Test, which is applicable at very low flow velocities. With this test the hydraulic conductivity of the formation is determined and the producing fissures localized in a deep borehole. In the cases of both low-permeability and high-permeability formations it is difficult to obtain representative samples of formation water. The use of a packersampler is described; this device allows pumping from the total length of an uncased or screened borehole during sampling and provides samples representative of each level. (See also W89-05465) (Lantz-PTT)
W89-05504

NATIONAL SURFACE WATER SURVEY, WESTERN LAKE SURVEY (PHASE 1 - SYNOPTIC CHEMISTRY) QUALITY ASSURANCE REPORT,
Lockheed Engineering and Management Services Co., Inc., Las Vegas, NV.
M. E. Silverstein, M. L. Faber, S. K. Drouse, and T. E. Mitchell-Hall.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-19075. Price codes: A14 in paper copy, A01 in microfiche. November 1987. 292p, 12 fig, 37 tab, 20 ref, 13 append.

Descriptors: *Lakes, *Surface water, *Synoptic analysis, *Quality control, *Data acquisition, Surveys, Water sampling, Water analysis, Monitoring, Data collections, Data interpretation, Precision, Statistical analysis.

The quality assurance program for the Western Lake Survey--Phase I was designed to ensure that the data collected were of known and acceptable quality. The quality assurance program was based on similar activities conducted for the Eastern Lake Survey--Phase I and included the following major elements: selection of analytical laboratories, training of field sampling and field laboratory crews, on-site evaluation of field and analytical laboratories, daily communications with survey participants, and verification and evaluation of data collected. Numerous quality assurance and quality control samples (e.g., blanks, duplicates, audits, spikes, and check samples) were used to identify, qualify, and quantify sources of sampling and analytical variability in terms of precision, accuracy, bias, and analytical detectability. The relative importance of these sources of variation was assessed by comparative statistical evaluations. Until all of the phases of the National Surface Water Survey have been conducted and their data sets are available for comparison, an assessment of Western Lake Survey--Phase I data quality cannot be considered complete. It can be stated, however, that the final data set represents data of high quality that can be used with confidence in the calculation of population estimates. Precision, accuracy, and detectability estimates generally met survey data quality objectives. Samples were complete, analyses were performed within specified holding times, and 10 of 15 strata met sampling completeness criteria. Quality assurance samples adequately

characterized the routine lake water samples, with the exception that field audit samples did not represent the midrange of the lake water sample analyte concentrations. (Lantz-PTT)
W89-05513

WATER SUPPLY AND SANITATION IN THE HEALTH SECTOR IN THE ASIA REGION: INFORMATION NEEDS AND PROGRAM PRIORITIES,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
J. Briscoe.
Water and Sanitation for Health Project, Washington, DC. WASH Technical Report No. 36, February 1986. 45p, 6 fig, 18 tab, 71 ref. AID Contract 5942-C-00-4085-00, Project 936-5942.

Descriptors: *Developing countries, *Water supply, *Sanitation, *Water management, *Public health, Costs, Finances, Public policy, Urban areas, Rural areas, Water treatment, Wastewater treatment.

The objective of this report is to identify and discuss concepts which are central in defining the appropriate role for water supply and sanitation services within the context of the health sector in less developed countries. The core of the paper is the development of a framework for identifying the portions of the overall costs of water supply and sanitation services that are: (i) serving non-health needs which are recognized by the consumers (and are correctly borne by the consumers themselves), and (ii) serving unrecognized and often external health needs (and are correctly support from public funds). The framework is used to assess two major issues: what are the information needs if rational policies are to be devised, and what appear to be the conditions under which investment of health-sector resources in water supply and sanitation projects may be appropriate. (Lantz-PTT)
W89-05517

7B. Data Acquisition

MODELS OF SUBSURFACE HYDROLOGY OF SEDIMENTARY BASINS,
Alberta Univ., Edmonton. Dept. of Geology.
For primary bibliographic entry see Field 2F.
W89-04566

DYE TRACING: ITS APPLICATION TO GROUND WATER LAW FOR DEFINING 'SUBTERRANEAN STREAMS' IN KARST TERRANES,
Southwest Texas State Univ., San Marcos.
For primary bibliographic entry see Field 6E.
W89-04593

RECOMMENDED PROCEDURE FOR EVALUATING THE EFFECTS OF SPILLS OF HAZARDOUS MATERIALS ON GROUND WATER QUALITY IN KARST TERRANES,
National Park Service, Mammoth Cave, KY.
For primary bibliographic entry see Field 5G.
W89-04595

USE OF FRACTURE TRACE ANALYSIS IN KARST TERRANES FOR ENVIRONMENTAL REMEDIAL ACTION PLANNING: A CASE STUDY,
Bionetics Corp., Warrenton, VA.
For primary bibliographic entry see Field 5B.
W89-04599

SPECIALIZED INVESTIGATION TECHNIQUES FOR DEFINING KARSTIC CAVITIES,
Golder Associates, Mississauga (Ontario).
T. G. Carter, M. L. J. Maher, A. P. Annan, and J. A. Richard.
IN: Proceedings of the Environmental Problems in Karst Terranes and Their Solutions Conference. National Water Well Association, Dublin, OH. 1986. p 345-367, 13 fig, 9 ref.

Descriptors: *Karst, *Construction, *Data acquisition, *Geological surveys, *Remote sensing, *Geologic mapping, Airports, Geophysics, Gravity studies, Drilling, Aerial photography, Radar.

Blasting near the access road to a new airport for St. Anthony, Newfoundland, Canada, exposed a large open cavity. The site investigation program was highly successful and cost effective. The systematic integrated approach maximized the site coverage and minimized the investigation time. Geological mapping and air photo interpretation indicated the extent of karstic features and thrust faulting in the vicinity of the airport. Geophysical surveys provided the only means to effectively and efficiently examine the subsurface conditions over the entire area of the airport site within the required time. Radar was effective in mapping open and clay filled bedding planes to depths in excess of 20 m in most areas of the airport site. Gravity work provided additional control on the extent of the major fracture zone at the Airport Terminal Building and corroborated radar data interpretations. Diamond drilling provided the essential link between the geophysical interpretation and the geological conditions as well as quantitative rock quality parameters. Information was collected in time for design modification prior to completion of construction. Site construction excavations confirmed the overall investigation conclusions. (See also W89-04586) (Hammond-PTT)
W89-04603

WATER TRACING USING A SCANNING SPECTROFLUOROMETER FOR DETECTION OF FLUORESCENT DYES,
Missouri Dept. of Natural Resources, Rolla. Div. of Geology and Land Survey.
J. W. Duley.
IN: Proceedings of the Environmental Problems in Karst Terranes and Their Solutions Conference. National Water Well Association, Dublin, OH. 1986. p 389-406, 5 fig, 1 tab, 22 ref.

Descriptors: *Path of pollutants, *Groundwater pollution, *Groundwater movement, *Tracers, *Wastewater outfall, *Dye releases, *Scanning spectrofluorometry, *Karst, Fluorescence, Dyes, Missouri.

A scanning spectrofluorometer has been used to detect four fluorescent tracers concurrently. The spectrofluorometer provides output through a recorder or printer which plots fluorescence intensity versus wavelength. Tracers are identified on the basis of their fluorescence characteristics distinguished from background fluorescence and interference between tracers is minimal. Quantitative measurements of multiple tracers in water are also possible. Significant savings in personnel time and field expenses may be realized in a detailed water tracing study through multiple simultaneous tracer injections, as compared to single periodic injections. Case histories of actual water traces conducted in Missouri karst terranes using the spectrofluorometer for tracer detection are discussed to illustrate the capabilities and limitations of the instrument. In addition, a summary of information on selected fluorescent tracers is included. (See also W89-04586) (Author's abstract)
W89-04606

AQUIFER PROTECTION PLANNING FOR CRITICAL KARST GROUND WATER SUPPLIES; A COORDINATED LOCAL AND STATE APPROACH FOR KENTUCKY,
Kentucky Natural Resources and Environmental Protection Cabinet, Frankfurt. Div. of Water.
For primary bibliographic entry see Field 5G.
W89-04608

USE OF SPONTANEOUS POTENTIAL IN THE DETECTION OF SUBTERRANEOUS FLOW PATTERNS IN AND AROUND SINKHOLES,
Virginia Military Inst., Lexington. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2F.
W89-04611

ASSESSMENT BY ELECTRICAL RESISTIVITY METHODS OF POTENTIAL GEOLOGICAL HAZARDS IN KARSTIC TERRANES,
Florida Univ., Gainesville. Dept. of Geology.
For primary bibliographic entry see Field 8E.
W89-04612

USE OF GROUND PENETRATING RADAR TECHNIQUES TO AID IN THE DESIGN OF ON-SITE DISPOSAL SYSTEMS,
University of Central Florida, Orlando.
S. S. Kuo, and H. G. Stangland.
IN: Proceedings of the Environmental Problems in Karst Terranes and Their Solutions Conference. National Water Well Association, Dublin, OH. 1986. p 502-525, 13 fig, 1 tab, 7 ref.

Descriptors: *Groundwater, *Hydraulics, *Land disposal, *Remote sensing, *Karst hydrology, *Florida, *Sinkholes, *Radar, Groundwater movement, Subsidence, Clays, Aquifer, Characteristics, Engineering geology, Geomorphology.

A Ground Penetrating Radar survey was conducted at an 11-acre site in Okahumpka, Florida. The site is to be developed for a land application system. A grid of approximately 50 ft spacing was staked out over the entire area. The ground penetrating radar data indicated a continuous clayey layer over the entire area with some sinkhole characteristics. Four general types of ground penetrating radar profiles were mapped at the site. The largest part of the site has a continuous clayey layer with no depression or limerock signatures. Another area shows a layer of hard clay overlying the limestone. The other two areas appear to have numerous cavities. In one of these two areas the clayey layer is depressed uniformly. Numerous small cavity signatures appear at shallow depths ranging form 20 to 30 ft. There is no evidence of recent sinkhole occurrence. In the two cavity areas there are several large cavity signatures at deeper depths ranging from 40 to 80 ft. The clayey layer is sharply depressed. The ground surface appears to have subsidence in these areas. This area is suspected as high potential for sinkhole activity. Groundwater movement in the surficial field program verified this hypothesis. (See also W89-04586) (Author's abstract)
W89-04613

ELECTRIC EARTH RESISTIVITY SURVEY OF THE MACON-TAYLORVILLE RIDGED-DRIFT AQUIFER,
Illinois State Geological Survey Div., Champaign.
For primary bibliographic entry see Field 2F.
W89-04627

WATER RESOURCES ACTIVITIES IN KENTUCKY, 1986.
Geological Survey, Louisville, KY. Water Resources Div.
R. J. Faust.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. Open-File Report 86-71, 1986. 58p, 10 fig, 1 tab.

Descriptors: *Data collections, *Kentucky, *Water resources, *Data acquisition, *Hydrologic studies, Research priorities, Information exchange.

The U.S. Geological Survey, Water Resources Division, conducts three major types of activities in Kentucky in order to provide hydrologic information and understanding needed for the best management of Kentucky's and the Nation's water resources. These activities are: (1) Data collection and dissemination; (2) Water-resources appraisals (interpretive studies); and (3) Research. Activities described in some detail following: (1) collection of surface - and groundwater data; (2) operation of stations to collect data on water quality, atmospheric deposition, and sedimentation; (3) flood investigations; (4) water use; (5) small area flood hydrology; (6) feasibility of disposal of radioactive disposal in deep crystalline rocks; (7) development of a groundwater model for the Louisville area; (8) travel times for streams in the Kentucky River Basin; (9) the impact of sinkholes and streams on

groundwater flow in a carbonate aquifer system; (10) sedimentation and erosion rates at the Maxey Flats Radioactive Waste Burial site; and (11) evaluation of techniques for evaluating the cumulative impacts of mining as applied to coal fields in Kentucky. (Lantz-PTT)
W89-04658

USE OF BOREHOLE NEUTRON LOGS TO ESTIMATE MOISTURE CONTENT IN THE UNSATURATED ZONE OF AN ALLUVIAL AQUIFER,
Geological Survey, San Juan, PR. Water Resources Div.
V. Quinones-Aponte, and R. A. Carrasquillo.
IN: Third Caribbean Islands Water Resources Congress. Proceedings of a Symposium held in St. Thomas, U.S. Virgin Islands, July 22-25, 1986. p 57-60, 4 fig, 4 ref.

Descriptors: *Logging (Recording) *Data acquisition, *Boreholes, *Alluvial aquifers, *Moisture content, Aeration zone, Mathematical studies, Graphical analysis.

The neutron borehole logging tool was calibrated for the determination of moisture content in the unsaturated zone of an alluvial aquifer. A continuous core sample was collected to a depth of 15 ft from the unsaturated zone. Moisture content and other soil properties were determined by standard soil-laboratory techniques. The neutron logs profile was correlated to moisture content. The first correlation included all the data points within the unsaturated zone. A correlation coefficient of 0.72 was obtained. An inspection of the plotted data showed that points at the upper extreme of the fitted line departed significantly. A second correlation was tried eliminating data points 1, 3, and 5 which fell too low in the first trial. An almost perfect correlation coefficient of 0.99 was obtained for the data points that were included in the second trial. The criteria used to select the data points for the second correlation trial was that all these points also fell on the left most limit of the neutron profile. The neutron logs profile, which is like a type of harmonic curve seems to be affected by an undefined factor. Analyzing the shape of the neutron profile it is inferred that hysteresis is the most probable phenomena that is affecting this moisture content profile. Although correlating neutron logs to moisture content is not a straight forward procedure, with an appropriate analysis, calibrated neutron logging tools can be used to determine the moisture content within the unsaturated zone of aquifers. Moisture content should be determined for calibration purposes at least at every foot of depth. Measurements of other elements or factors which may produce the harmonic curve effect might be included in further studies. (See also W89-04665) (Lantz-PTT)
W89-04674

GROUND-WATER FLOW CHARACTERISTICS DESCRIBED IN QUANTITATIVE DYE TRACING IN KARST TERRANE IN NORTH-CENTRAL, KENTUCKY,
Geological Survey, Louisville, KY. Water Resources Div.
D. S. Mull, and J. L. Smoot.
IN: Third Caribbean Islands Water Resources Congress. Proceedings of a Symposium held in St. Thomas, U.S. Virgin Islands, July 22-25, 1986. p 65-67, 6 ref.

Descriptors: *Groundwater movement, *Karst, *Geohydrology, *Data acquisition, *Kentucky, *Dye releases, *Tracers, Dyes, Mathematical studies, Data interpretation.

Groundwater tracing with various tracers such as dye, has long been a useful tool for delineating groundwater basins, identifying point to point flow connections, and defining flow characteristics in carbonate and fracture rock terrane. The most often used dye tracing technique is qualitative in which a discrete sample of water is tagged with a tracer and the arrival of that water is monitored at various points by passive samplers or periodic sampling by field personnel. Generally, the most common tracers are fluorescent dyes, such as fluorescein, that can be sorbed on packets of activated coconut charcoal placed in suspected resurgences such as down-gradient springs. Quantitative dye tracing requires frequent sampling and discharge measurements at all sampled resurgences during the time the dye is passing. This requires the use of automatic samplers or frequent sampling by field personnel, a fluorometer, and the use of a conservative fluorescsent dye. Analysis of time-concentration curves provides information on groundwater flow characteristics such as elapsed time to arrival of leading edge, trailing edge, peak concentration, and centroid of the dye cloud. The typical time-concentration response curve is bell shaped but skewed. In order to compare the results of different traces, the dye concentrations are generally adjusted for dye loss. In this procedure, the measured concentrations are multiplied by the ratio of the dye mass injected to the dye mass recovered, assuming all resurgences were sampled. Because the travel time, magnitude of the peak concentration and time between selected points on the rising and falling limb of the dye recovery curve (residence time) generally vary with discharge, repeat traces under different flow conditions are useful in developing a predictive capability for different flow conditions. Repeat traces from a ponor to a water supply spring in the Elizabethtown, Ky. area, showed that the arrival time of the leading edge of the dye cloud ranged from 8 to 26 hours and that the travel time, based on the centroid of the dye cloud, was 13.3 and 56.3 hours, respectively. Repeat traces also yield travel time-discharge curves that show the variation of travel time with discharge. (Lantz-PTT)
W89-04676

IMPROVEMENT OF RUNOFF PRODUCING MODEL FOR U. S. 'SCS' METHOD,
Wuhan Inst. of Hydraulic and Electric Power Engineering (China).
For primary bibliographic entry see Field 2E.
W89-04709

UP-TO-DATE METHOD TO STUDY MARSH-RIDDEN AREAS IN WEST SIBERIA,
Gosudarstvennyi Gidrologicheskii Inst., Leningrad (USSR). Lab. of Swamp Hydrology.
For primary bibliographic entry see Field 2H.
W89-04733

FIRST RADIOCESIUM PROFILE AND SNOW COVER MASS MEASUREMENTS,
National Board of Waters, Helsinki (Finland). Hydrological Office.
For primary bibliographic entry see Field 5A.
W89-04744

IMPROVED LABORATORY DISPERSANT EFFECTIVENESS TEST,
Environmental Protection Agency, Cincinnati, OH. Office of Research and Development.
J. S. Shum.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-184882. Price codes: A06 in paper, A01 in microfiche Report No. EPA/600/2-88/023, March 1988. 105p, 10 fig, 24 tab, 18 ref. Contract 68-03-3203.

Descriptors: *Testing procedures, *Oil spill cleanup, *Chemical analysis, *Water analysis, *Dispersants, Improved Laboratory Dispersant Effectiveness Test, Revised Standard Dispersant Effectiveness Test, Laboratory equipment.

A preliminary evaluation of the Improved Laboratory Dispersant Effectiveness Test indicates this test has a better scientific basis, uses a simpler apparatus, requires less laboratory space, and uses more up-to-date laboratory techniques to evaluate dispersants for floating oil on the ocean surface than the previous Revised Standard Dispersant Effectiveness Test. The improved test provides a method to evaluate dispersant effectiveness in a physically realistic condition by creating a test energy level dynamically similar to the small-scale ocean turbulence responsible for droplet formation. The preliminary evaluation shows a possible improvement in precision over the existing EPA method. (Author's abstract)
W89-04752

USE OF RESPIROMETRY FOR OPERATING ACTIVATED SLUDGE PLANTS TREATING TOXIC WASTEWATERS,
Bioprocess Engineering, Inc., Wilmington, DE.
For primary bibliographic entry see Field 5D.
W89-04788

STATISTICAL QUALITY CONTROL FOR THE ANALYTICAL LABORATORY,
CompuChem Labs., Inc., Research Triangle Park, NC.
R. J. Whitehead.
IN: Analytical Techniques and Residuals Management in Water Pollution Control Specialty Conference April 19-20, 1988. Water Pollution Control Federation, Alexandria, VA 22314-1994. p 62-72, 7 fig, 7 ref.

Descriptors: *Water analysis, *Quality control, *Control charts, *Computer programs, Data base management, Standards, Management planning, Chemical analysis, Laboratory information management systems.

The use of control charts and related performance statistics is essential in a comprehensive quality assurance program for the analytical laboratory. In the CompuChem statistical quality control (QC) program: (1) the control charts, lacking some degree of specificity, would be used primarily for documenting lab performance and observing long-range trends, and (2) the Laboratory Management System (computerized data base manager) would be used to characterize the status of every analysis, whether or not all QC criteria were met. This objective was accomplished through a system of condition codes (two-letter codes used to describe sources of failure and the results of repeated analyses). These data are presented in tables and graphs in monthly QA reports to management, and support managers in initiating corrective actions and reinforcing good laboratory practices. Sample forms and graphs used in the CompuChem QA/QC program are included in this paper. (See also W89-04782) (Rochester-PTT)
W89-04789

FUNDAMENTALS AND ANALYTICAL APPLICATIONS OF BIOLUMINESCENCE,
Georgia Univ., Athens. Dept. of Biochemistry.
J. E. Wampler.
IN: Analytical Techniques and Residuals Management in Water Pollution Control Specialty Conference April 19-20, 1988. Water Pollution Control Federation, Alexandria, VA 22314-1994. p 110-116, 1 tab, 16 ref.

Descriptors: *Bioluminescence, *Bioassay, *Water analysis, *Luciferins, *Luciferases, Enzymes, Biochemistry, Monitoring, Toxins, Invertebrates, Pollutant identification, Genotoxic agents, Microorganisms.

The chemistry of bioluminescence is described, including that of the firefly, bacteria, earthworm, soft coral (Renilla and Aequorea), and ostracod (Cyridina). The generic terms luciferin and luciferase cover a wide range of chemical structures. Most bioluminescent systems involve a chemistry in which the final step is the generation of an excited state product + CO2. The organic substrates (luciferins) are typically large heterocyclic, aromatic compounds. Bacterial luminescence differs from the others because it uses the well-known coenzyme flavine mononucleotide in the role of luciferin along with fatty aldehydes and molecular oxygen. In addition to these systems, which use molecular oxygen, several employ hydrogen peroxide, as in the bioluminescent earthworm. Bioluminescent systems have extreme detection sensitivity comparable to that of radioactivity-based systems and they involve important biological chemicals in the reactions. Both the firefly and bacterial systems have been used to monitor water quality and toxic pollutants. Microbial contamination is indicated by ATP released from lysed cells, this may be analyzed using the firefly system, dark

mutants of luminous bacteria are used to monitor, the presence of genotoxic agents in water, and the effects of various chemicals on bacterial metabolism have all been measured using bioluminescence. (See also W89-04782) (Rochester-PTT)
W89-04794

WASTE TESTING AND QUALITY ASSURANCE.
For primary bibliographic entry see Field 5A.
W89-04816

QUALITY ASSURANCE ON THE GROUNDWATER MONITORING TASK FORCE FACILITY ASSESSMENT PROGRAM,
Life Systems, Inc., Cleveland, OH.
For primary bibliographic entry see Field 5A.
W89-04824

APPLICATION OF GEOPHYSICAL METHODS IN ENVIRONMENTAL AND MUNICIPAL ENGINEERING: THEORETICAL STUDY,
Valtion Teknillinen Tutkimuskeskus, Espoo (Finland).
P. Saksa, and J. Korkealaakso.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-157987. Price codes: E06 in paper copy, A01 in microfiche. Report No. VTT/RR-505, 1987. 126p, 55 fig, 3 tab, 110 ref.

Descriptors: *Geophysics, *Surveys, *Geophysical surveys, *Data acquisition, *Groundwater pollution, *Environmental engineering, Electrical studies, Electromagnetic waves, Soil temperature, Model studies, Theoretical analysis, Salinity, Landfills.

The fundamental theoretical aspects of geophysics applied in environmental surveys are reviewed. The main emphasis is on analyzing electrical, electromagnetic, and soil temperature measurements. The retrophysical basis necessary for quantitative interpretation and modeling is covered. Some theoretical formulas and laboratory measurements of water samples indicate that salinity (TDS) can be interpreted from surface measurements and that TDS is a relatively reliable indicator of groundwater contamination. A case study conducted at an existing landfill site at TUUSULA, Finland, indicated that soil temperature measurements were not useful in evaluating hydrogeologic conditions in groundwater flow systems. (Lantz-PTT)
W89-04842

PRELIMINARY INVESTIGATION OF THE SHORT-TERM EFFECTS OF STORMS ON SEDIMENTARY CHARACTERISTICS AND THE NEARSHORE FAUNA USING THE SEDIMENT PROFILING CAMERA SYSTEM,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
C. A. Miller-Way, and D. A. Nelson.
Available from the National Technical Information Service, Springfield, VA 22161. Miscellaneous Paper D-88-4, September 1988. Final Report. 19p, 6 fig, 4 tab, 17 ref.

Descriptors: *Photography, *Storms, *Sedimentation, *Coastal waters, *Cameras, *Benthic fauna, Storm tides, Polychaetes, Amphipods, Ecosystems.

A pilot study (SUPERDUCK) was conducted to investigate the short-term effects of disturbance by storms on nearshore sandy-bottom habitats at Duck, NC, in October 1988. Sedimentary characteristics and benthic faunal composition were assessed using a sediment profiling camera system and a traditional benthic sampling technique. Technical problems precluded benthic sampling during the prestorm period. Poststorm sampling at five stations showed that the nearshore benthic fauna can be divided into two disturbance/faunal zones on the basis of faunal composition and sedimentary characteristics. The first zone (four inshore stations, ranging in depth from approximately 4 to 12 m) was characterized by low faunal abundance and was numerically dominated by amphipods and a diverse assemblage of polychaetes. The second zone (the farthest offshore station at a depth of approximately 14 m) was characterized by high faunal abundance and was numerically dominated by capitellid polychaetes. The sediment profiling camera system did not provide much insight into benthic community responses to short-term disturbance in this sandy environment. This study and another study in the SUPERDUCK program were carried out simultaneously, demonstrating that when equipment needs and goals are similar and with proper planning and communication, physical and biological studies can be conducted concurrently in a cost-effective manner. Additional studies may give insight into the short-term effects of human disturbances such as dredging and disposal operations on sedimentary characteristics and the benthic community characteristics of this habitat. (Author's abstract)
W89-04856

PESTICIDE ASSESSMENT GUIDELINES SUBDIVISION N, CHEMISTRY: ENVIRONMENTAL FATE. SERIES 161-2 AND 161-3, PHOTOLYSIS STUDIES. ADDENDUM 4 ON DATA REPORTING,
Environmental Protection Agency, Washington, DC. Office of Pesticide Programs.
For primary bibliographic entry see Field 5B.
W89-04874

PESTICIDE ASSESSMENT GUIDELINES SUBDIVISION N, CHEMISTRY: ENVIRONMENTAL FATE. SERIES 161-1, HYDROLYSIS STUDIES ADDENDUM 3 ON DATA REPORTING,
Environmental Protection Agency, Washington, DC. Office of Pesticide Programs.
For primary bibliographic entry see Field 5B.
W89-04875

IMPROVED STREAMFLOW AND WATER QUALITY MONITORING USING A MICROPROCESSOR-BASED SYSTEM,
Forest Service, Ogden, UT. Intermountain Research Station.
R. E. Babbitt.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-149810. Price codes: A02 in paper copy, A01 in microfiche. Research Note INT-377, November 1987. 5p, 4 fig, 1 tab.

Descriptors: *Hydrologic data collections, *Monitoring, *Data acquisition, *Streamflow, *Computers, Water sampling, Measuring instruments.

Accurate data quantifying effects of road construction, timber harvesting, and other forest management activities on water quality are often essential for evaluation of land management activities. Collecting such information has been difficult and costly for the Forest Service due to the remoteness of many sites and limitations of available sampling equipment. Advances in electronic technology now make possible microprocessor-based systems that reduce costs and enhance the information collected. One such microprocessor-based data acquisition system is described for monitoring streamflow and collecting water samples at remote sites. The system was more efficient and provided more precise data during high-intensity, short-duration rainstorms than the system used previously. (Lantz-PTT)
W89-04876

GUIDELINES FOR MEASURING THE PHYSICAL, CHEMICAL, AND BIOLOGICAL CONDITION OF WILDERNESS ECOSYSTEMS,
Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.
For primary bibliographic entry see Field 7A.
W89-04881

SOME MODELS FOR RAIN AND CLOUDS ATTENUATION OF MILLIMETER WAVES,
National Telecommunications and Information Administration, Boulder, CO. Inst. for Telecommunication Sciences.
E. J. Dutton, H. T. Dougherty, and D. C. Hyovalti.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-160809. Price codes: A03 in paper copy, A01 in microfiche. NTIA Report 87-225, November 1987. 36p, 12 fig, 5 tab, 22 ref, append.

Descriptors: *Remote sensing, *Radar, *Passive electromagnetic sensing, *Millimeter waves, *Model studies, *Rain, *Clouds, Statistical analysis, Rainfall, Hydrologic models, Climatology, Mathematical studies.

Rainfall observational data were processed by least-squares curve-fitting to call attention to some of the desirable aspects of such fitting. The curve-fitting techniques are illustrated for annual rainfall and worst-month rainfall distributions, but are as readily applicable for distributions of rain-caused attenuation or scattering. Specific rain attenuation data observed at Huntsville, AL at 28.8, 57.6, and 96.1 GHz were used to construct the third part of a CONUS-wide climatology for use in obtaining the distribution of specific attenuation at geographic locations within these zones. The other two climatic-zone analyses have been described in earlier reports, so that with this report, this rather broad-scale analysis is now complete. The feasibility of determining zenith cloud attenuation distributions at millimeter-wave frequencies was examined, basically using radiosonde observations as the main indicator of cloud location and occurrence, supplemented to some degree by other weather data. A 5-year sample for Washington, DC, was examined and results presented. Recommendations are made for additional work on both the CONUS rain attenuation climatology and for extended cloud attenuation analysis. (Author's abstract)
W89-04882

NATIONAL STATUS AND TRENDS PROGRAM FOR MARINE ENVIRONMENTAL QUALITY SPECIMEN BANK PROJECT: FIELD MANUAL,
National Oceanic and Atmospheric Administration, Rockville, MD. Ocean Assessments Div.
G. G. Lauenstein, S. A. Wise, R. Zeisler, B. J. Koster, and M. M. Schantz.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-157821. Price codes: A03 in paper copy, A01 in microfiche. NOAA Technical Memorandum NOS OMA 37, December 1987. 34p, 6 fig, 4 tab, 5 ref, 2 append.

Descriptors: *Environmental quality data, *Sampling, *Data acquisition, *Marine environment, Benthic environment, Fish, Bivalves, Marine sediments, Sample preservation, Sample preparation.

Sample collection protocols developed and used for the collection of benthic fish, bivalve mollusks, and associated sediments have provided specimens from > 77 sites nationwide, which have been submitted for inclusion in the Specimen Bank housed at the National Bureau of Standards in Gaithersburg, MD. Specimens are preserved at liquid-nitrogen temperature with minimal degradation expected for decades. Initial analysis of archived samples provides data that is used for Quality Assurance purposes since the data can be compared to data generated by other laboratories involved in the National Status and Trends projects. In addition, these primary data will allow a quantification of archived sample degradation during storage, if any. Analysis of banked specimens in the future will allow the derivation of baseline values for newly defined environmental contaminants, and the preservation of these samples for retrospective analysis will make historical marine samples available as new and improved analytical procedures are developed. (Lantz-PTT)
W89-04891

COST EFFECTIVENESS OF THE STREAM-GAGING PROGRAM IN MISSOURI,
Geological Survey, Rolla, MO. Water Resources Div.
L. Waite.
Available from Books and Open File Report Sec-

tion, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 87-4254, 1987. 38p, 5 fig, 7 tab.

Descriptors: *Streamflow, *Cost analysis, *Stream gaging, *Missouri, *Gaging stations, Discharge measurement, Flow discharge, Resource allocation, Budgeting, Statistical methods, Measuring instruments, Data acquisition, Simulation.

This report documents the results of an evaluation of the cost effectiveness of the 1986 stream-gaging program in Missouri. Alternative methods of developing streamflow information and cost-effective resource allocation were used to evaluate the Missouri program. Alternative methods were considered statewide, but the cost effective resource allocation study was restricted to the area covered by the Rolla field headquarters. The average standard error of estimate for records of instantaneous discharge was 17 percent; assuming the 1986 budget and operating schedule, it was shown that this overall degree of accuracy could be improved to 16 percent by altering the 1986 schedule of station visitations. A minimum budget of $203,870, with a corresponding average standard error of estimate 17 percent, is required to operate the 1986 program for the Rolla field headquarters; a budget of less than this would not permit proper service and maintenance of the stations or adequate definition of stage-discharge relations. The maximum budget analyzed was $418,870, which resulted in an average standard error of estimate of 14 percent. Improved instrumentation can have a positive effect on streamflow uncertainties by decreasing lost records. An earlier study of data uses found that data uses were sufficient to justify continued operation of all stations. One of the stations investigated, Current River at Doniphan (07068000) was suitable for the application of alternative methods for simulating discharge records. However, the station was continued because of data use requirements. (Author's abstract)
W89-04898

SELECTED REPORTS THAT INCLUDE COMPUTER PROGRAMS PRODUCED BY THE U.S. GEOLOGICAL SURVEY FOR SIMULATION OF GROUND-WATER FLOW AND QUALITY,
Geological Survey, Reston, VA. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-04904

QUALITY-ASSURANCE RESULTS FOR FIELD PH AND SPECIFIC-CONDUCTANCE MEASUREMENTS, AND FOR LABORATORY ANALYSIS, NATIONAL ATMOSPHERIC DEPOSITION PROGRAM AND NATIONAL TRENDS NETWORK--JANUARY 1980-SEPTEMBER 1984,
Geological Survey, Denver, CO. Water Resources Div.
For primary bibliographic entry see Field 5A.
W89-04920

REVIEW OF THE HYDROLOGIC DATA-COLLECTION NETWORK IN THE ST. JOSEPH RIVER BASIN, INDIANA,
Geological Survey, Indianapolis, IN. Water Resources Div.
E. J. Crompton, J. G. Peters, R. L. Miller, J. A. Stewart, and K. J. Banaszak.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4157. 6 fig, 10 tab, 39 ref.

Descriptors: *Groundwater data, *Water resources data, *Stream gaging, *Hydrological data collections, *Networks, *Data acquisition, *St. Joseph River Basin, Lakes, Groundwater level. Streamflow, Hydrology, Groundwater movement, Irrigation effects, Water level, Monitoring, Meteorological data collection, Rain gages.

The St. Joseph River Basin data-collection network in the St. Joseph River for streamflow, lake, ground water, and climatic stations was reviewed. The network review included only the 1700 sq mi part of the basin in Indiana. The streamflow network includes 11 continuous-record gaging stations and one partial-record station. Based on areal distribution, lake effect, contributing drainage area, and flow-record ratio, six of these stations can be used to describe regional hydrology. Gaging stations on lakes are used to collect long-term lake-level data on which to base legal lake levels, and to monitor lake-level fluctuations after legal levels are established. More hydrogeologic data are needed for determining the degree to which grouhd water affects lake levels. The current groundwater network comprises 15 observation wells and has four purposes: (1) to determine the interaction between groundwater and lakes; (2) to measure changes in groundwater levels near irrigation wells; (3) to measure water levels in wells at special purpose sites; and (4) to measure long-term changes in water levels in areas not affected by pumping. Seven wells near three lakes have provided sufficient information for correlating water levels in wells and lakes but are not adequate to quantify the effect of groundwater on lake levels. Water levels in five observation wells located in the vicinity of intensive irrigation are not noticeably affected by seasonal withdrawals. The National Weather Sevice operates eight climatic stations in the basin primarily to characterize regional climatic conditions and to aid in flood forecasting. The network meets network-density guidelines established by the World Meterological Organization for collection of precipitation and evaporation data but not guidelines suggested by the National Weather Service for density of precipitation gages in areas of significant convective rainfalls. (Author's abstract)
W89-04931

COMPARISON OF FLUME AND TOWING METHODS FOR VERIFYING THE CALIBRATION OF A SUSPENDED-SEDIMENT SAMPLER,
Geological Survey, Minneapolis, MN. Water Resources Div.
J. P. Beverage, and J. C. Futrell.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4193, 1986. 12p, 4 fig, 1 tab, 2 ref.

Descriptors: *Sampling, *Suspended sediments, *Sediment sampler, *Calibrations, Towing tank method, Flume method, Comparison studies.

Suspended-sediment samplers must sample isokinetically (at stream velocity) in order to collect representative water samples of rivers. Each sampler sold by the Federal Interagency Sedimentation Project has been adjusted to sample isokinetically and tested in a flume to verify the calibration. The test program for a modified U.S. P-61 sampler provided an opportunity to compare flume and towing tank tests. Although the two tests yielded statistically distinct results, the difference between them was quite small. The lack of turbulence in the towing test probably accounts for the slight disparity between the two relations. The conclusion is that verifying the calibration of any suspended-sediment sampler by either the flume or towing method should give acceptable results. (Author's abstract)
W89-04956

EVALUATING SOLUBLE TOXICANTS IN CONTAMINATED SOILS,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Biology.
For primary bibliographic entry see Field 5A.
W89-04973

COMPARISON OF THE STANDARD AND DIRECT-MPN METHODS FOR FAECAL COLIFORM ENUMERATION IN SOME NIGERIAN WATERS,
Port Harcourt Univ. (Nigeria). Dept. of Microbiology.
For primary bibliographic entry see Field 5A.
W89-04994

FAST-NEUTRON-ACTIVATION ANALYSES OF VARIOUS WATER SOURCES OF EAST CENTRAL INDIANA,
Ball State Univ., Muncie, IN. Dept. of Physics and Astronomy.
For primary bibliographic entry see Field 5A.
W89-05006

METHOD FOR DETERMINING METAL SPECIES IN SOIL PORE WATER,
Queen's Univ., Kingston (Ontario). Dept. of Chemistry.
For primary bibliographic entry see Field 5A.
W89-05017

DETERMINATION OF AMINOPEPTIDASE ACTIVITY IN LAKEWATER BY A SHORT TERM KINETIC ASSAY AND ITS APPLICATION IN TWO LAKES OF DIFFERING EUTROPHICATION,
Rutgers Shellfish Research Lab., Port North Norris, NJ. Dept. of Oyster Culture.
T. R. Jacobsen, and H. Rai.
Archiv fuer Hydrobiologie AHYBA4, Vol. 113, No. 3, p 359-370, September 1988. 6 fig, 2 tab, 13 ref.

Descriptors: *Lakes, *Eutrophic lakes, *Aquatic bacteria, *Enzymes, *Nitrogen compounds, *Amino acids, Aminopeptidase, Fluorescent, Assay.

The use of a fluorescent assay for measuring aminopeptidase in freshwater was evaluated and a rapid kinetic method was developed for the estimation of aminopeptidase activity. Continuous measurements of aminopeptidase activity were monitored in lakewater amended with substrate. Rates of activity in lake water were determined in only 3-5 minutes. Aminopeptidase activity in bacteria sized particles accounted for a significant flux of organic nitrogen in the lakes sampled. Comparison of aminopeptidase measurements with simultaneous determinations of dissolved combined amino acids in lakewater samples indicate that the total flux of combined amino acid nitrogen is greater than predicted by aminopeptidase activity alone. (Author's abstract)
W89-05024

CHLORINE 36 AND TRITIUM FROM NUCLEAR WEAPONS FALLOUT AS TRACERS FOR LONG-TERM LIQUID AND VAPOR MOVEMENT IN DESERT SOILS,
New Mexico Inst. of Mining and Technology, Socorro. Dept. of Geoscience.
For primary bibliographic entry see Field 2G.
W89-05057

DEPOSITION OF SOLIDS IN DRILLING FLUIDS ON BOREHOLE WALLS,
Washington State Univ., Pullman. Dept. of Civil Engineering.
M. Y. Corapcioglu.
Water Resources Research WRERAO, Vol. 24, No. 11, p 1893-1900, November 1988. 3 fig, 28 ref, append. PSC - Research Award Program, grant 667319.

Descriptors: *Wells, *Drilling fluids, *Borehole geophysics, *Suspended solids, *Porous media, *Particle deposition, Mathematical analysis.

Suspended solid particles are introduced into well bores during various operations such as the use of drilling muds. These particles in drilling muds can build a filter cake on the wall of the bore and migrate to the porous formation immediately adjacent to the well bore. In either case, the entrainment and deposition of particles cause an observed decline in productivity of some wells or increase of injection pressures. A study was conducted to develop a practical mathematical approach to the formation of a filter cake at the face of the well bore. This was achieved first by defining and identifying relevant mechanisms which contribute to the cake formation and particle migration in porous media. Then, conservation principles ex-

pressed in terms of quantifications of these mechanisms led to a system consisting of governing partial differential equations. These equations were averaged to obtain analytical expressions to predict the cake thickness as a function of solid concentration, injection rate, or filtrate rate, and time. The results were compared with experimental data obtained by some researchers. Excellent agreement was seen between the theoretical and experimental results. (Author's abstract)
W89-05058

PRIMARY PRODUCTION IN LAKES HURON AND MICHIGAN: IN VITRO AND IN SITU COMPARISONS,
National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.
For primary bibliographic entry see Field 2H.
W89-05077

VALIDITY OF AN ECOTOXICOLOGICAL TEST SYSTEM: SHORT-TERM AND LONG-TERM EFFECTS OF ARSENATE ON MARINE PERIPHYTON COMMUNITIES IN LABORATORY SYSTEMS,
Goeteborg Univ. (Sweden). Dept. of Botany.
For primary bibliographic entry see Field 5A.
W89-05105

INDUCED COMMUNITY TOLERANCE IN MARINE PERIPHYTON ESTABLISHED UNDER ARSENATE STRESS,
Goeteborg Univ. (Sweden). Dept. of Botany.
For primary bibliographic entry see Field 5A.
W89-05106

SEQUENTIAL EXTRACTION OF IRON-PHOSPHATE AND CALCIUM-PHOSPHATE FROM SEDIMENTS BY CHELATING AGENTS,
Leiden Rijksuniversiteit (Netherlands). Dept. of Population Biology.
H. L. Golterman, and A. Booman.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IVTLAP, Vol. 23, No. 2, p 904-909, August 1988. 4 tab, 9 ref.

Descriptors: *Chemical analysis, *Limnology, *Sediments, *Phosphates, *Phytoplankton, Iron, Calcium, Hydrogen ion concentration.

A method has been developed to extract iron-bound and calcium-bound phosphates from calcareous sediments at pH values near those of the sediment itself. Fe-bound phosphate seems easily available for phytoplankton growth, Ca-bound phosphate is probably not so easily available; its availability is related to crystal size. In about 30 minutes Fe-bound P is extracted with 0.02 M Ca-NTA with dithionite in 0.1 M TRIS-buffer at the same pH as the sediment. Subsequently CA-bound P can be extracted with Na-EDTA, still at the same pH, in about one hour. Phosphates adsorbed onto Fe(OH)3 or onto freshly precipitated CaCO3 are dissolved with the Ca-NTA for 100% and 1-2%, respectively, and with the Na-EDTA for 10 and 100%, respectively. Extracts from a calcareous sediment (Camargue) did not contain organic phosphate. Iron-bound phosphate can be extracted from acid sediments with 0.02 M Ca-NTA with ascorbic acid or NH2OH as reducing agents. (Author's abstract)
W89-05179

LIQUID NITROGEN PRETREATMENT IN ATP EXTRACTION FROM SEDIMENTS,
Parma Univ. (Italy). Ist. di Ecologia.
R. Antonietti, S. Veronesi, C. Ferrini, L. Tarozzi, and R. Pisi.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IVTLAP, Vol. 23, No. 2, p 910-914, August 1988. 4 fig, 8 ref.

Descriptors: *Limnology, *Sediments, *Biological samples, *Chemical analysis, Rivers, *Enzymes, Extraction methods, Biochemical activity, Acid extraction, Liquid nitrogen.

The microbial ATP pool is the result of a dynamic production/consumption balance: for this reason all ATP extraction methods must stop cellular biochemical activity in a shorter time than the ATP turnover time, which is usually estimated in seconds. Even when this condition is not met, a modification in the production/consumption balance, together with a change in the ATP pool, becomes highly probable. Acid extraction of ATP from sediment has appeared to be more effective than the boiling tris-EDTA buffer method. The degree of cellular suffering that occurs during acid treatment was evaluated by using liquid nitrogen. Biological samples were taken from sediments in different kinds of environments (rivers, water treatment plants, etc.) or made up in the laboratory with Nutrient Broth BBL. Acid ATP extraction was carried out. The instantaneous effects of acid on the microbial ATP pool were studied with a peristaltic pump. ATP concentrations were measured. The hypothesis of a change in the ATP pool of sediments consequent to treatment with sulfuric acid for ATP extraction was verified by means of liquid nitrogen pretreatment. The effects of acid on the ATP pool were not constant and were probably related to both the physiological condition and types of microorganisms. Liquid nitrogen pretreatment, if applied correctly, prevents changes in the ATP pool. (Davis-PTT)
W89-05180

COMPARISON OF CHLOROPHYLL-A CONCENTRATIONS MEASURED BY FLUOROMETRIC HPLC AND SPECTROPHOTOMETRIC METHODS IN HIGHLY EUTROPHIC SHALLOW LAKE KASUMIGAURA,
National Inst. for Environmental Studies, Ibaraki (Japan).
A. Otsuki, and N. Takamura.
Internationale Vereinigung fuer Theoretische und Angewandte Limnologie. Verhandlungen IVTLAP, Vol. 23, No. 2, p 944-951, August 1988. 5 fig, 8 ref.

Descriptors: *Chemical analysis, *Limnology, *Cyanophyta, *Eutrophic lakes, *Chlorophyll a, *Fluorometry, *Chromatography, *Lake Kasumigaura, *Japan, Tokyo, Algae, Chlorophyll b, Carp, Eutrophication.

Seasonal changes in the concentration of chlorophyll-a in highly eutrophic shallow Lake Kasumigaura were reexamined. Lake Kasumigaura, the second largest lake in Japan, is located in the eastern part of the Kanto Plain, 60 km northeast of Tokyo. Heavy blooms of blue-green algae have been observed in the whole lake in the summer. The blooms start at the most inner parts of both Takahamairi and Tsuchiurairi Bays during May to June, which receive nutrient rich inflowing waters, and gradually develop to the center. In August, the blooms cover the whole lake. One of the important sources of nutrients is excretion by carps in net pen culture within the lake. For chlorophyll analyses, water samples were taken monthly from the surface layer. The concentrations by the trichromatic method were apparently higher than those by the fluorometric HPLC method except for winter time, while the trends of the seasonal changes were similar. There was a linear relationship between both methods, but the slopes in the relationship were different in each season. The concentrations by the trichromatic method were about 2.5 times higher than those by fluorometric HPLC method during August and September at all stations. In February and March, both methods were nearly equal. During the other months, those by trichromatic method were about 1.4 times higher than those by fluorometric HPLC method. No significant concentrations of pheophytins-a and -b were observed at the stations during this study. Even when green algae were dominant, the ratios of chlorophyll-a to -b were less than 20:1. The study suggests that the trichromatic method should be avoided in highly eutrophic lakes because it is strongly influenced by the physiological conditions of phytoplankton. (Davis-PTT)
W89-05181

MEASUREMENT OF PHYTOPLANKTON PIGMENTS IN FRESHWATER: WHERE DO WE GO FROM HERE,
Rutgers Shellfish Research Lab., Port North Norris, NJ. Dept. of Oyster Culture.
For primary bibliographic entry see Field 2H.
W89-05182

HYDRAULIC TEST OF STREAMER SEDIMENT TRAP,
Coastal Engineering Research Center, Vicksburg, MS.
J. D. Rosati, and N. C. Kraus.
Journal of Hydraulic Engineering JHEND8, Vol. 114, No. 12, p 1527-1532, December 1988. 3 fig, 6 ref.

Descriptors: *Measuring instruments, *sediment sampler, *Samplers, *Hydraulic design, *Sediment transport, *Trap efficiency, Seashores, Streamer sediment trap, Nets, Comparison studies, Longshore currents, Particle size.

Results are presented of a laboratory experiment performed to determine the optimal hydraulic design of the streamer trap, which was developed and applied to measure longshore sediment transport rates in the surf zone. Of the 22 streamer configurations tested, the H-type streamer trap had hydraulic efficiencies closest to unity over the range of flow speeds employed. The efficiency remained near unity for both uniform flow and flow in the bottom boundary layer. The present experiment confirmed the higher-than-unity hydraulic efficiency previously reported for the pressure difference H-S trap, and it was also shown that the efficiency of the H-S trap varies appreciably with elevation in the water column. For application to sandy beaches, hydraulic efficiencies much greater than unity may enhance scours at the bed, as well as cause selective entrapment dependent on hydraulic grain size. The next stage in development of the streamer trap, now in planning, will be a laboratory investigation of its sediment trapping characteristics. (Author's abstract)
W89-05217

TREATMENT OF WATER FOR AQUATIC BACTERIAL GROWTH STUDIES,
Thames Water Authority, London (England).
For primary bibliographic entry see Field 5F.
W89-05219

SECCHI DISC TRANSPARENCY AND TURBIDITY,
Upstate Freshwater Inst., Inc., Syracuse, NY.
S. W. Effler.
Journal of Environmental Engineering JOEDDU, Vol. 114, No. 6, p 1436-1447, December 1988. 3 fig, 2 tab, 20 ref.

Descriptors: *Testing procedures, *Secchi disks, *Opacity, *Transparency, *Turbidity, Optical properties, Mathematical equations, Mathematical analysis, Hydrologic data collections.

The optical principles that govern the two common measures of clarity, turbidity (T sub n and NTU) and Secchi disc transparency (SD and m) are reviewed. It is demonstrated that these measurements differ fundamentally in their sensitivity to light attenuating processes, and that they cannot be uniquely specified by each other. A generalized inverse relationship between SD and T sub n is developed, of the form SD = N"/T sub n (where N" is a variable coefficient), that may be valuable in some cases in estimating one parameter from the other. The coefficient N" can range from 4.0-10.1, depending on the relative contributions of absorption and scattering to light attenuation, the relationship between T sub n and the scattering coefficient (b, 1/m), and the conditions that prevail during measurement of SD. Optical measurements made on five test systems, encompassing a wide range of optical conditions, indicate T sub n is a reliable estimator of b, and support the developed relationship between SD and T sub n and related optical theory. (Author's abstract)
W89-05232

OPTIMAL SAMPLING OF DOMESTIC SOLID WASTE,
Asian Development Bank, Manila (Philippines). Environmental Unit.
B. N. Lohani, and S. M. Ko.
Journal of Environmental Engineering JOEDDU, Vol. 114, No. 6, p 1479-1483, December 1988. 1 fig, 1 tab, 7 ref.

Descriptors: *Sampling, *Domestic wastes, *Solid wastes, *Testing procedures, Optimization, Precision, Statistical analysis, Probability distribution.

A general approach to determining the optimal sample size and the number of samples for solid waste sampling is presented using solid waste data collected from Taipei City, Taiwan. This study examined 12 combinations of distribution and transformation for various sample sizes, ranging from 46.88 kg to to 3,000 kg. The results demonstrate that any distribution or transformation could be used for percentage separation data when the sample size is as large as 3,000 kg. For arcsine transformation and gamma distribution a significantly smaller sample size of 93.75 kg was found to represent the overall waste. The results also show that selection of arcsine transformation and a normal distribution without a thorough analysis of all the combinations might lead to inaccurate representation of the sample size and number. (Author's abstract)
W89-05235

GEOCHEMICAL MONITORING OF ATMOSPHERIC HEAVY METAL POLLUTION: THEORY AND APPLICATIONS,
For primary bibliographic entry see Field 5A.
W89-05242

PRECIPITATION COMPOSITION AT CAPE GRIM, 1977-1985,
Commonwealth Scientific and Industrial Research Organization, Aspendale (Australia). Div. of Atmospheric Research.
For primary bibliographic entry see Field 5A.
W89-05244

GOALS AND DATA COLLECTION DESIGNS FOR WATER QUALITY MONITORING,
Inland Waters Directorate, Vancouver (British Columbia). Monitoring and Agreements Div.
For primary bibliographic entry see Field 7A.
W89-05267

EFFECTS OF SPATIAL ORIENTATION OF MULTIPLE PLATE ARTIFICIAL SUBSTRATES ON INVERTEBRATE COLONIZATION,
Geological Survey, Menlo Park, CA. Water Resources Div.
K. V. Slack, R. F. Ferreira, R. C. Averett, and S. S. Kennelly.
Water Resources Bulletin WARBAQ, Vol. 24, No. 4, p 781-789, August 1988. 1 fig, 2 tab, 81 ref.

Descriptors: *Benthic fauna, *Substrates, *Sampling, *Stream biota, Species diversity, Aquatic populations, Biological properties, Light penetration, Streamflow, Flow characteristics, Aquatic habitats.

Jumbo multiple samplers were suspended in a river at 0.3 and 1 m depth in one of three orientations: interplate spaces closed to downwelling light and open to flow, open to light and flow, or open to light and closed to flow. Mean numbers of colonizing taxa and individuals were not significantly different among orientations after eight weeks of submergence. All variables tested decreased significantly with depth. Mean number of taxa, number of individuals (1 m only), and insect diversity decreased between samplings at four and eight weeks for samplers that were closed to light and open to flow. All orientations, depths, and durations had one-half to two-thirds of the total taxa. Colonization was affected by location in the river and position on sampler suspension equipment. The results indicate lack of orientation effects on colonization or high variability that obscured such effects. The sampler suspension equipment possibly increased among sampler variability by forming artificial snag habitats, and interplate light and flow conditions at different orientations may not have been sufficiently distinct to elicit different biological responses. Individual samplers provided diverse microhabitats regardless of orientation, but it would be prudent to include orientation among the variables considered in use of multiple plate samplers. (Author's abstract)
W89-05268

EXTRACT PREPARATION AND COMPARISON OF FLUOROMETRIC, CHROMATOGRAPHIC (HPLC) AND SPECTROPHOTOMETRIC DETERMINATIONS OF CHLOROPHYLL-A,
Zurich Univ., Kilchberg (Swizerland). Hydrobiological-Limnological Station.
F. Schanz, and H. Rai.
Archiv fuer Hydrobiologie AHYBA4, Vol. 112, No. 4, p 533-539, June 1988. 3 fig, 1 tab, 13 ref.

Descriptors: *Sample preparation, *Chlorophyll A, *Limnology, *Comparison studies, *Fluorometry, *Chromatography, *Spectrophotometry, *Water analysis, Phytoplankton, Primary productivity, Sampling, Switzerland, Lakes, Aphotic zone, Photosynthesis, Laboratories, Aquatic animals, Biochemistry.

A previously published method of extraction and fluorometric determination of chlorophyll-a is compared with photometric and High-Performance Liquid Chromatography (HPLC) methods. Special attention is paid to filtration and grinding efficiencies: glass fiber filters remove ca. 98% of the total filtrable chlorophyll A and the subsequent grinding process (in 90% acetone in the absence of light) allows the extraction of almost 95% of this amount. The results fo photometric, fluorometric and HPLC determinations of chlorophyll A in water samples from several Swiss lakes differ little from one another. Routine investigations are normally carried out with pigment mixtures from natural phytoplankton populations by photometry of fluorometry. Experiments with increasing amounts of carotinoids or chlorophyll A point to the fact that there are interactions between chlorophyll A and the other components of pigment mixture, which leads to errors in chlorophyll determinations. These errors are, however, in most cases, less than 10% of the measured value of both fluorometric and spectrophotometric chlorophyll A determinations. (Author's abstract)
W89-05292

APPARATUS FOR THE INVESTIGATION OF MICROBIAL REACTION RATES IN SEDIMENT SUSPENSIONS,
GKSS - Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.). Inst. fuer Chemie.
F. Schroeder, G. Blocker, and H.-D. Knauth.
Analytica Chimica Acta ACACAM, Vol. 213, No. 1/2, p 221-225, October 15, 1988. 2 fig, 14 ref.

Descriptors: *Laboratory equipment, *Suspended sediments, *Biodegradation, *Path of pollutants, *Path of pollutants, *Fate of pollutants, *Microbiological studies, Metabolism, Chemical reactions, Kinetics, Bacteria, Sediments, *Biotransformation, Chromatography, Gas chromatography, Bacterial physiology, Culturing techniques, Equilibrium, Oxygen, Acidity, Sampling, Chemical analysis, Sediment-water interface.

An apparatus is described for the determination of microbe-induced reaction rates in stirred sediment/water suspensions and material fluxes across the sediment/water interface of undisturbed sediment cores. The system consists of a closed gas loop coupled to a reaction vessel, thus maintaining an equilibrium between water and gasphase. The vessel is equipped with sensors for oxygen, pH, and redox potential, and with facilities for sampling. On-line gas analysis is done by gas chromatography with a sensitive helium-ionization detector. The oxygen concentration in the system is regulated by computer-controlled injection of oxygen into the gas loop. As an example, flux measurements of an undisturbed sediment core from the River Elbe estuary in northern Germany are presented and discussed. (Author's abstract)
W89-05366

GROUND-WATER FLUCTUATIONS IN WISCONSIN,
Geological Survey, Madison, WI. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-05389

TROPHIC CLASSIFICATION OF WASHINGTON LAKES USING RECONNAISSANCE DATA,
Geological Survey, Tacoma, WA. Water Resources Div.
For primary bibliographic entry see Field 2H.
W89-05394

ADVANCED INSTRUMENTAL METHODS FOR ANALYZING ORGANICS IN SOLID WASTE: THE USE OF GAS CHROMATOGRAPHY/MATRIX ISOLATION INFRARED SPECTROSCOPY (GC/MIIR) AND SUPERCRITICAL FLUID CHROMATOGRAPHY (SFC) FOR WASTE CHARACTERIZATION,
Argonne National Lab., IL. Analytical Chemistry Lab.
For primary bibliographic entry see Field 5A.
W89-05396

DEVELOPING A STATE WATER PLAN: GROUND-WATER CONDITIONS IN UTAH, SPRING OF 1984,
Geological Survey, Salt Lake City, UT. Water Resources Div.
For primary bibliographic entry see Field 4B.
W89-05402

STANDARD METHODS FOR THE EXAMINATION OF WATER AND WASTEWATER.
American Public Health Association, Washington, DC.
For primary bibliographic entry see Field 5A.
W89-05429

GATHERING OF DATA FOR MODELLING,
Danmarks Geologiske Undersoegelse, Copenhagen.
For primary bibliographic entry see Field 7A.
W89-05504

NATIONAL SURFACE WATER SURVEY, WESTERN LAKE SURVEY (PHASE 1 - SYNOPTIC CHEMISTRY) QUALITY ASSURANCE REPORT,
Lockheed Engineering and Management Services Co., Inc., Las Vegas, NV.
For primary bibliographic entry see Field 7A.
W89-05513

WINNING WITH WATER: SOIL-MOISTURE MONITORING FOR EFFICIENT IRRIGATION,
INFORM, Inc., New York.
For primary bibliographic entry see Field 3F.
W89-05542

METHODS OF EXPLORATION AND ANALYSIS OF THE ENVIRONMENT OF AQUATIC VEGETATION,
Station Biologique de la Tour du Valat, Arles (France).
H. L. Golterman, R. S. Clymo, E. P. H. Best, and J. Lauga.
IN: Vegetation of Inland Waters. Kluwer Academic Publishers, Boston, MA. Handbook of Vegetation Science Series Vol. 15/1. 1988. p 31-62, 3 tab, 3 fig, 68 ref.

Descriptors: *Aquatic vegetation, *Vegetation, *Aquatic plants, *Remote sensing, *Sampling, *Measuring instruments, Flora, Aquatic weeds,

Bottom sampling, Water sampling, Biological samples, Temperature, Light intensity, Light penetration, Light quality, Trace elements, Water quality, Water depth, Stages, Scuba diving.

Aquatic plants are found wherever there is liquid water and at least a modest flux of light. Morphometric and hydrological variables important in studying aquatic vegetation include waterflow, stage, velocity, depth, and discharge. Remote sensing from both aerial photographs and digital data from satellites can be used to obtain data on water quality, chlorophyll, and wetland delineation. SCUBA diving is increasingly used for research on submerged plants. Chemical sampling requires the investigation of spatial and temporal variability. Corers are used to obtain sediment samples in which stratification is preserved while dredges or grab samplers are used to sample the top few centimetres of bottom deposits. Light and temperature are of interest in all vegetation studies and usually simple to measure. Chemical substances in the water can be divided into suspended material and dissolved compounds. Major ions, present in relatively high concentrations, are normally determined by classical titrations and precipitation procedures. The 'minor' elements are normally measured by colorimetric procedures. (See also W89-05543) (White-Reimer-PTT)
W89-05545

PHOTOSYNTHESIS OF AQUATIC PLANTS UNDER NATURAL CONDITIONS,
Roskilde Universitetscenter (Denmark). Inst. of Life Sciences and Chemistry.
For primary bibliographic entry see Field 2H.
W89-05546

EVALUATION OF A SUGGESTED SEQUENCE FOR THE CHEMICAL EXTRACTION OF SOLUBLE AMORPHOUS PHASES FROM CLAYS,
S. L. Rettig, and B. F. Jones.
IN: Selected Papers in the Hydrologic Sciences 1986. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Supply Paper 2290. 1986. p 127-137, 8 fig, 3 tab, 17 ref.

Descriptors: *Clays, *Solute transport, *Chemical analysis, *Sediments, Silicates, Chemical extraction, Particulate matter, Ion exchange.

Because the separation of soluble amorphous phases of clays is an important aspect of sediment-water interaction, the efficacy of a sequential treatment for their chemical extraction was evaluated. Treatment consisted of extraction by 0.1 M sodium pyrophosphate, followed by 1 M hydroxylamine hydrochloride and either sodium acetate or acetic acid, and finally by 0.2 M ammonium oxalate. Both the dissolved material and the remaining fine particulates were chemically analyzed after each step. Seven samples were chosen to represent a broad spectrum of ultrafine clays from environments of aqueous deposition. Significant amounts of clay mineral components were removed at each step fo the extraction sequence. Some changes in the clays can be attributed to ion exchange or loss of intergrade complexes, but dissolution of clay crystallites with or without precipitation of amorphous aluminosilicate also must occur. (See also W89-055886) (Author's abstract)
W89-05597

COMPARISON OF VELOCITY INTERPOLATION METHODS FOR COMPUTING OPEN-CHANNEL DISCHARGE,
J. M. Fulford, and V. B. Sauer.
IN: Selected Papers in the Hydrologic Sciences 1986. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Supply Paper 2290. 1986. p 139-144, 4 fig, 1 tab, 2 ref.

Descriptors: *Gaging, *Standards, *Velocity distribution, *Open-channel flow, *Discharge measurement, Rivers, Mississippi River, Ohio River, Georgia, South Carolina, Mathematical equations, Estimating, Interpolation.

The Dutch members of a subcommittee of the International Organization for Standardization have suggested the use of the ratio V/square root of h (where V = mean velocity and h = is the depth of flow measured at a vertical) to interpolate the horizontal velocity profile from a small number of measured velocities. The velocity profile is computed by assuming that (1) the ratio V/square root of h varies linearly between measured velocities and (2) the ratio V/square root of h is constant from the nearest measured velocity to the bank. This method (the ratio interpolation method) and two other discharge computation methods, a modified ratio interpolation method and a linear velocity fit method, were tested on data from the Mississippi and Ohio rivers and seven smaller rivers in Georgia and South Carolina. Results from all the methods were compared with a 'true' discharge computed by the standard mid-section method. Absolute mean error for the methods using all the measured cross section depths with a velocity approximation scheme ranged from 10.2% to 1.1%. The results indicated that the use of five velocity measurements in a known cross section might be adequate to compute discharges by using the ratio interpolation method or a more simple linear interpolation scheme. (See also W89-05586) (Author's abstract)
W89-05598

PRELIMINARY EVALUATION OF A DISCHARGE COMPUTATION TECHNIQUE THAT USES A SMALL NUMBER OF VELOCITY OBSERVATIONS,
For primary bibliographic entry see Field 2E.
W89-05599

FLORIDA ACID DEPOSITION STUDY: FIVE-YEAR DATA SUMMARY.
Environmental Science and Engineering, Inc., Gainesville, FL.
For primary bibliographic entry see Field 5B.
W89-05762

ASSESSMENT OF VARIABILITY IN PERFOMANCE OF WET ATMOSPHERIC DEPOSITION SAMPLERS,
Geological Survey, West Point, NY. Water Resources Div.
R. C. Graham, J. K. Robertson, and J. Obal.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 87-4125, 1987. 152 p, 6 fig, 36 tab, 16 ref.

Descriptors: *Monitoring, *Samplers, *Precipitation samplers, *Water quality, *Precipitation, *Chemistry of precipitation, *Atmoshperic deposition, *New York, Sampling, Quality control, Fallout, Data collections, Precipitation data.

The variability in performance of two brands of wet/dry atmospheric deposition samplers were compared for 1 year at a sincle site. A total of nine samplers were used. Samples were collected weekly and analyzed for pH, specific conductance, common chemical constituents, and sample volume. Additionally, data on the duration of each sampler opening were recorded using a microdatalogger. These data disprove the common perception that samplers remain open throughout a precipitation event. The sensitivity of sampler sensors within the range tested did not have a defineable impact on sample collection. The nonnormal distribution within the data set necessitated application of the nonparametric Friedman Test to assess comparability of sample chemical composition and volume between and within sampler brands. Statistically significant differences existed for most comparisons, however the test did not permit quantification of their magnitudes. Differences in analyte concentrations between samplers were small. (USGS)
W89-05778

7C. Evaluation, Processing and Publication

INTEGRATED HYDROGEOLOGICAL DATA BASES: THEIR USE AND MISUSE,
Alberta Research Council, Edmonton.
For primary bibliographic entry see Field 2F.
W89-04573

USE OF THERMAL DATA TO RESOLVE AND DELINEATE HYDROLOGIC FLOW SYSTEMS IN SEDIMENTARY BASINS: AN EXAMPLE FROM THE UINTA BASIN, UTAH,
Utah Univ., Salt Lake City. Dept. of Geology and Geophysics.
For primary bibliographic entry see Field 2F.
W89-04578

SOLMNEQF: A COMPUTER CODE FOR GEOCHEMICAL MODELING OF WATER-ROCK INTERACTIONS IN SEDIMENTARY BASINS,
Battelle Project Management Div., Willowbrook, IL.
For primary bibliographic entry see Field 2F.
W89-04580

CHARACTERISATION OF CARBONATE AQUIFERS: A CONCEPTUAL BASE,
Bristol Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 2F.
W89-04587

GROUNDWATER LEVELS IN NEBRASKA, 1984,
Geological Survey, Lincoln, NE. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-04615

GROUNDWATER LEVELS IN NEBRASKA, 1985,
Geological Survey, Lincoln, NE. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-04616

1985 WATER QUALITY MONITORING RIVERS AND STREAMS.
Indiana Dept. of Environmental Management, Indianapolis. Office of Water Management.
For primary bibliographic entry see Field 5B.
W89-04625

GROUND-WATER AND SURFACE-WATER DATA FOR FREDERICK COUNTY, MARYLAND,
Maryland Geological Survey, Baltimore.
J. R. Dine, M. D. Tompkins, and M. T. Duigon.
Maryland Geological Survey Basic Data Report No. 15, 1985. 240p, 5 fig, 13 tab, 43 maps, 11 ref.

Descriptors: *Water resources data, *Frederick County, *Hydrologic data collections, *Groundwater, *Surface waters, *Data collections, *Maryland, Streamflow, Water analysis, Wells, Springs, Groundwater level, Geophysics, Water quality.

This report presents hydrologic data collected in Frederick County, Maryland. Surface water data include streamflow measurements, basin characteristics, and chemical analyses of water collected at 25 sites. Groundwater data include locations and descriptions of 1,898 wells and 130 springs, chemical analyses of water from 45 wells and 24 springs, water levels measured in 58 selected wells, and geophysical logs of three wells. Temperature, pH, dissolved solids, carbon dioxide, and iron are some of the more important characteristics that determine suitability for many uses. Common ion data and trace-element data for groundwater for surface water are presented. In addition, bottom materials were analyzed for trace elements and pesticides. Suspended sediment data are also presented. Groundwater and surface water appropriation data

based on permit issued by the Maryland Water Resources Administration for non-farming uses of greater than 10,000 gal/d (average) are also included. (Lantz-PTT)
W89-04632

ANNUAL REPORT TO THE PECOS RIVER COMMISSION ON INVESTIGATIONS BEING MADE IN NEW MEXICO AND TEXAS.
Geological Survey, Albuquerque, NM. Water Resources Div.
Geological Survey, 1986. 23p, 2 fig, 13 tab.

Descriptors: *Water resources data, *Data collections, *Water quality, *Pecos River, *Hydrologic studies, *New Mexico, *Texas, Water storage, Reservoirs, Suspended sediment, Water temperature, Chemical analysis, Streamflow.

Investigations in New Mexico and Texas made by the Water Resources Division of the U.S. Geological Survey, in cooperation with the Pecos River Commission during the 1986 calendar year are provided as hydrologic data tables, with a summary of costs for the fiscal year ending June 30, 1986. Field measurements were made on streamflow, air temperature, water temperature, specific conductance, pH, dissolved oxygen, fecal coliform, and streptococci bacteria. Beginning in 1981, annual dissolved-solids values are computed from daily specific conductances and mean daily discharge. Composite periods were monthly or were determined from changes in the specific conductances of the daily samples and from changes in discharge. All samples collected were analyzed for sediment concentrations and a few samples for each station were analyzed for particle size. Samples for size analysis were selected on the basis of stage or discharge, in an attempt to cover a wide range in discharge. Selection was also made to define seasonal changes in size distribution and concentration. Data presented include: reservoir storage, water quality (chemical quality, suspended sediments, stream temperatures), phreatophyte eradication and control, and streamflow and seepage run data. (See also W89-04634) (Lantz-PTT)
W89-04633

ANNUAL REPORT TO THE PECOS RIVER COMMISSION ON INVESTIGATIONS BEING MADE IN NEW MEXICO AND TEXAS.
Geological Survey, Albuquerque, NM. Water Resources Div.
Geological Survey, 1985. 23p, 2 fig, 13 tab.

Descriptors: *Water resources data, *Data collections, *Water quality, *Pecos River, *Hydrologic studies, *New Mexico, *Texas, Water storage, Reservoirs, Suspended sediment, Water temperature, Chemical analysis, Streamflow.

Investigations in New Mexico and Texas made by the Water Resources Division of the U.S. Geological Survey, in cooperation with the Pecos River Commission during the 1985 calendar year are provided as hydrologic data tables, with a summary of costs for the fiscal year ending June 30, 1985. Field measurements were made on streamflow, air temperature, water temperature, specific conductance, pH, dissolved oxygen, fecal coliform, and streptococci bacteria. An analysis of the performance of the USGS water quality minimonitors was made to the Pecos River Commission on May 24, 1985. The operation of the minimonitors was suspended effective June 1, 1985 due to various operational problems. Beginning in 1981 annual dissolved-solids values are computed from daily specific conductances and mean daily discharge. Composite periods were monthly or determined from changes in the specific conductances of the daily samples and from changes in discharge. In the Pecos River basin waters in 1985, suspended-sediment concentrations ranged considerably during the 1985 calendar year for the stations at Santa Rosa and Artesia. Very low concentrations were observed at the station at Terrero. Data presented include: reservoir storage, water quality (chemical quality, suspended sediments, stream temperatures), phreatophyte eradication and control, and streamflow and seepage run data. (Lantz-PTT)
W89-04634

POTENTIOMETRIC SURFACE OF THE UPPER FLORIDAN AQUIFER IN GEORGIA, MAY 1985, AND WATER-LEVEL TRENDS, 1980-85,
Georgia Dept. of Natural Resources, Atlanta.
For primary bibliographic entry see Field 2F.
W89-04638

LONG-TERM STAGE RECORDS OF LAKES IN FLORIDA,
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 2H.
W89-04639

LONG-TERM STREAMFLOW STATIONS IN FLORIDA, 1980,
Geological Survey, Tallahassee, FL. Water Resources Div.
D. W. Foose, and J. E. Sohm.
U.S. Geological Survey Map Series No. 107, 1983. 1p, 5 fig, 1 tab, 2 ref.

Descriptors: *Water resources data, *Maps, *Gaging stations, *Florida, *Streamflow, *Data collections, Rainfall, Data acquisition, Seasonal variation, Daily hydrographs, Networks.

The flow of streams varies daily, monthly, annually, and over a period of years as a result of variation in rainfall and changes brought about by man. A record of these variations is useful for predicting future streamflow and the longer the streamflow record, the greater its usefulness and reliability in making these predictions. A large map shows the location of the 236 streamflow stations in Florida with 10 or more years of record as of 1980; additional maps show stations (through 1980) with 10 to 20, 20 to 30, 30 to 40, 40 to 50, and more than 50 years of record, respectively. These 236 long-term streamflow stations meet the criteria for statistical analyses given in a study of the national streamflow. network. To determine streamflow, measurements of the velocity and the depth of the water are made. On natural streams the depth of the water and the streamflow are related. The depth of the water can be determined on a suitable gage, and from a number of measurements at different gage readings a rating curve or table of that relation can be developed. Streamflow can then be determined from the height of the water on the gage in conjunction with the rating curve or table. Streamflow may be measured at high or low flow (partial record), periodically, or daily. All daily record stations in Florida are equipped with automatic, continuous recording gages. (Lantz-PTT)
W89-04640

APPLICATION OF A NUMERICAL GROUND-WATER FLOW MODEL TO THE MUD LAKE AREA IN SOUTHEASTERN IDAHO,
Idaho Water and Energy Resources Research Inst., Moscow.
For primary bibliographic entry see Field 2F.
W89-04644

RECORDS OF GROUND-WATER RECHARGE, DISCHARGE, WATER LEVELS, AND CHEMICAL QUALITY OF WATER FOR THE EDWARDS AQUIFER IN THE SAN ANTONIO AREA, TEXAS, 1934-80.
Edwards Underground Water District, San Antonio, TX.
For primary bibliographic entry see Field 2F.
W89-04649

RECORDS OF GROUND-WATER RECHARGE, DISCHARGE, WATER LEVELS, AND CHEMICAL QUALITY OF WATER FOR THE EDWARDS AQUIFER IN THE SAN ANTONIO AREA, TEXAS, 1934-81.
Edwards Underground Water District, San Antonio, TX.
For primary bibliographic entry see Field 2F.
W89-04650

RECORDS OF GROUND-WATER RECHARGE, DISCHARGE, WATER LEVELS, AND CHEMICAL QUALITY OF WATER FOR THE EDWARDS AQUIFER IN THE SAN ANTONIO AREA, TEXAS, 1934-82.
Edwards Underground Water District, San Antonio, TX.
For primary bibliographic entry see Field 2F.
W89-04651

COMPILATION OF HYDROLOGIC DATA FOR THE EDWARDS AQUIFER, SAN ANTONIO AREA, TEXAS, 1983-84, WITH 1934-84 SUMMARY.
Edwards Underground Water District, San Antonio, TX.
For primary bibliographic entry see Field 2F.
W89-04652

COMPILATION OF HYDROLOGIC DATA FOR THE EDWARDS AQUIFER, SAN ANTONIO AREA, TEXAS, 1985, WITH 1934-85 SUMMARY.
Edwards Underground Water District, San Antonio, TX.
For primary bibliographic entry see Field 2F.
W89-04653

PUBLIC WATER SUPPLIES IN LOUISIANA. VOLUME 1: NORTHERN LOUISIANA,
Geological Survey, Baton Rouge, LA. Water Resources Div.
For primary bibliographic entry see Field 5F.
W89-04657

PROJECTED EFFECTS OF PROPOSED INCREASED PUMPAGE ON WATER LEVELS AND SALINITY IN THE SPARTA AQUIFER NEAR WEST MONROE, LOUISIANA,
Geological Survey, Baton Rouge, LA. Water Resources Div.
For primary bibliographic entry see Field 4B.
W89-04661

WATER-RESOURCES DATA FOR THE LOWER JAMES RIVER, DICKEY, LAMOURE, AND STUTSMAN COUNTIES, NORTH DAKOTA,
Geological Survey, Bismarck, ND. Water Resources Div.
For primary bibliographic entry see Field 2E.
W89-04664

INTEGRATION OF RAIN WATER CISTERN SYSTEMS WITH OTHER SOURCES OF WATER IN THE CARIBBEAN,
Caribbean Research Inst., St. Thomas, VI. Water Resources Research Center.
For primary bibliographic entry see Field 3B.
W89-04669

INTERPRETATION OF HYDROCHEMICAL FACIES OF GROUND WATER IN GRAND CAYMAN,
Water Authority, George Town (Cayman Islands).
For primary bibliographic entry see Field 2K.
W89-04673

ESTIMATES OF FRESHWATER PRODUCTION FROM COASTAL AQUIFERS USING AREA OF DIVERSION OF WELL FIELDS AND AREAL DISTRIBUTION OF CHLORIDE CONCENTRATIONS,
Geological Survey, Tuscaloosa, AL. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-04680

SIMULATION OF THE FLOW SYSTEM IN THE SHALLOW AQUIFER, DAUPHIN ISLAND, ALABAMA,
Geological Survey, Tuscaloosa, AL. Water Resources Div.
For primary bibliographic entry see Field 5B.
W89-04681

GROUND-WATER DATA FOR BOTTINEAU AND ROLETTE COUNTIES, NORTH DAKOTA,
Geological Survey, Bismarck, ND. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-04683

GROUND-WATER DATA FOR TOWNER COUNTY, NORTH DAKOTA,
Geological Survey, Bismarck, ND. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-04684

GROUND-WATER DATA FOR MCKENZIE COUNTY, NORTH DAKOTA,
Geological Survey, Bismarck, ND. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-04685

ANALYSIS OF PRINCIPAL COMPONENTS FOR SWAMP FORMING FACTORS IN HENGDUAN MOUNTAINS,
Changchun Inst. of Geography (China). Dept. of Swamp.
For primary bibliographic entry see Field 2H.
W89-04693

CONTRIBUTIONS TO THE STUDY OF PEATLANDS INFLUENCE ON MAXIMUM FLOW,
Institutul de Meteorologie si Hidrologie, Bucharest (Romania).
For primary bibliographic entry see Field 2E.
W89-04704

WATER AND ENERGY REGIME OF PALSA BOGS IN WEST SIBERIA,
Gosudarstvennyi Gidrologicheskii Inst., Leningrad (USSR). Lab. of Swamp Hydrology.
For primary bibliographic entry see Field 2H.
W89-04734

BEHAVIOUR AND IMPACT ASSESSMENT OF HEAVY METALS IN ESTUARINE AND COASTAL ZONES,
Institute for Soil Fertility, Haren (Netherlands).
For primary bibliographic entry see Field 5B.
W89-04772

LAS VEGAS SW QUADRANGLE GROUND WATER MAP,
Geological Survey, Carson City, NV. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-04829

RECONNAISSANCE OF THE WATER RESOURCES OF THE MCALESTER AND TEXARKANA QUADRANGLES, SOUTHEASTERN OKLAHOMA,
Geological Survey, Oklahoma City, OK. Water Resources Div.
M. V. Marcher, and D. L. Bergman.
Hydrologic Atlas 9, 1983. 2p, 4 maps.

Descriptors: *Water resources, *Maps, *Oklahoma, Groundwater budget, Chemical analysis, Data collections, Discharge, Precipitation, Runoff, Streamflow, Lakes.

The ninth atlas is the final issue of a series produced under a cooperative agreement entered into in 1967 between the Oklahoma Geological Survey and the Water Resources Division of the U.S. Geological Survey to make a regional assessment of the availability and quality of Oklahoma's water resources. The new atlas covers a large area of approximately 7,200 sq mi in the southeastern part of the State that includes all or part of eight counties: McCurtain, Pushmataha, Choctaw, Le Flore, Latimer, Pittsburg, Atoka, and Bryan. Each atlas in the series contains four large, colorful map sheets that offer graphic information on the amount and quality of both groundwater and surface water, including availability, chemical analyses, discharge, precipitation, runoff, stream-flow records, and surface area and capacity of lakes. One sheet offers an updated area geologic map at a scale of 1:250,000. (Lantz-PTT)
W89-04832

INDEXES TO SURFACE AND SUBSURFACE GEOLOGIC MAPPING IN OKLAHOMA, 1977-1979,
Oklahoma Geological Survey, Norman.
K. V. Luza, E. A. Ham, and P. R. Sanders.
Oklahoma Geological Survey Map GM-26, 1983. Plate 1: Index to Surface Geologic Mapping in Oklahoma, 1977-1979. Plate 2: Index to Subsurface Geologic Mapping in Oklahoma, 1977-1979. 2 plates, 78 ref.

Descriptors: *Maps, *Groundwater, *Surface waters, *Oklahoma, Data collections.

Two maps comprise this document which are indexes to surface and subsurface maps of Oklahoma, published or unpublished, color or monochrome, 1977-1979. (Lantz-PTT)
W89-04848

LONG-TERM MONITORING STUDIES IN THE FRESHWATER PORTION OF THE POTOMAC RIVER-THIRD ANNUAL REPORT, MAY 1985-DECEMBER 1985,
Academy of Natural Sciences of Philadelphia, Avondale, PA. Stroud Water Research Center.
For primary bibliographic entry see Field 2H.
W89-04885

SELECTED REPORTS THAT INCLUDE COMPUTER PROGRAMS PRODUCED BY THE U.S. GEOLOGICAL SURVEY FOR SIMULATION OF GROUND-WATER FLOW AND QUALITY,
Geological Survey, Reston, VA. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-04904

SOUTH LAKE TAHOE QUADRANGLE: VEGETATION MAP,
Geological Survey, Carson City, NV. Water Resources Div.
G. Berggren, and J. R. Harrill.
Nevada Bureau of Mines and Geology, Las Vegas Area, Map 2Ae, 1985. 1p (map).

Descriptors: *Urban hydrology, *Land use, *Maps, *Vegetation, *California, *Nevada, *Lake Tahoe, Infrared imagery, Satellite technology, Aerial photography, Land classification, Coniferous forests, Shrubs, Riparian vegetation, Alpine regions, Revegetation, Urban areas.

This map shows vegetation types and urban areas in California and Nevada southeast of Lake Tahoe. It was compiled from a previous publication, infrared satellite imagery, color satellite imagery, and color aerial photographs and followed by field checking. Land areas are categorized as forest, shrub, riparian, alpine, disturbed, or urban. Forest areas are shown as pure pine, mixed conifer, fir, or lodgepole pine. Shrub areas are subdivided into big sagebrush/bitterbrush/rabbit brush/mule ears or mondtaine chaparral. Riparian areas may be deciduous or meadow/marsh. Alpine areas are defined as low-growing grasses/herbs/shrubs/scattered trees. Disturbed areas are relatively large areas that have been denuded in recent years by some natural or man-caused disturbance. Some of them are being successfully revegetated with grasses and chaparral species. Urban areas are land where natural vegetation associations have been significantly altered by man. (Shidler-PTT)
W89-04907

PERCENTAGE CHANGE IN SATURATED THICKNESS OF THE HIGH PLAINS AQUIFER, WEST-CENTRAL KANSAS, 1950 TO AVERAGE 1985-87,
Geological Survey, Lawrence, KS. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-04908

COMPUTER PROGRAMS FOR COMPUTING PARTICLE-SIZE STATISTICS OF FLUVIAL SEDIMENTS,
Geological Survey, Denver, CO. Water Resources Div.
H. H. Stevens, and D. W. Hubbell.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, Co 80225. USGS Water Resources Investigations Report 86-4141. 1986. 17p, 1 fig, 2 tab.

Descriptors: *Data processing, *Data interpretation, *Computer programs, *Fluvial sediments, *Sediment grading, Statistical analysis, Silt, Sand, Clays.

Two versions of computer programs for inputing data and computing particle-size statistics of fluvial sediments are presented. The FORTRAN 77 language versions are for use on the Prime computer, and the BASIC language versions are for use on microcomputers. The size-statistics program compute Inman, Trask, and Folk statistical parameters from phi values and sizes determined for 10 specified percent-finer values from inputed size and percent-finer data. The program also determines the percentage gravel, sand, silt, and clay, and the Meyer-Peter effective diameter. Documentation and listings for both versions of the programs are included. (Author's abstract)
W89-04921

DIGITAL DATA BASE OF LAKES ON THE NORTH SLOPE, ALASKA,
Geological Survey, Anchorage, AK. Water Resources Div.
K. M. Walker, J. York, D. Murphy, and C. E. Sloan.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, Co 80225. USGS Water Resources Investigations Report 86-4143. 1986. 13p, 5 fig, 1 tab.

Descriptors: *Lakes, *Alaska, *Data collections, *Arctic, Cold regions, Data processing, Remote sensing, Computers, Lake classification, Potential water supply.

The National Mapping Division and Water Resources Division of the U.S. Geological Survey have produced a digital data base of approximately 23,330 lakes on the North Slope of Alaska. The inventoried region consists of the area north of the 69th parallel and is composed of sixteen 1 degree by 3 degree quadrangles. The data base includes (1) locations of lake centers in latitude and longitude, (2) a unique number for each lake within a quadrangle, and (3) acreage for water classes (deep, shallow or turbid, and ice) within each lake and lake total. The digital data base is an easily accessible storage and retrieval system that will allow for rapid identification of a particular lake or region of lakes and its characteristics. The data base is designed to accommodate field study data such as lake depth, water quality, volume of water, ice thickness, and other pertinent information. (Author's abstract)
W89-04922

PROGRAMMERS MANUAL FOR A ONE-DIMENSIONAL LAGRANGIAN TRANSPORT MODEL,
Geological Survey, NSTL Station, MS. Water Resources Div.
D. H. Schoellhamer, and H. E. Jobson.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, Co 80225. USGS Water Resources Investigations Report 86-4144. 1986. 101p, 12 fig, 2 tab, 15 ref, 5 append.

Descriptors: *Path of pollutants, *Computer models, *Model studies, *Data processing, *Water quality, *Transport models, River flow, Streamflow, Suspended sediment, Dissolved oxygen, Temperature, Computer programs, Simulation.

A one-dimensional Lagrangian transport model for simulating water-quality constituents such as temperature, dissolved oxygen, and suspended sediment in rivers is presented in this Programmers Manual. Lagrangian transport modeling techniques, the model's subroutines, and the user-written decay-coefficient subroutine are discussed in detail. Appendices list the program codes. The Programmers Manual is intended for the model user who needs to modify code either to adapt the model to a particular need or to use reaction kinetics not provided with the model. (Author's abstract)
W89-04923

USERS MANUAL FOR A ONE-DIMENSIONAL LAGRANGIAN TRANSPORT MODEL,
Geological Survey, NSTL Station, MS. Water Resources Div.
D. H. Schoellhamer, and H. E. Jobson.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, Co 80225. USGS Water Resources Investigations Report 86-4145. 1986. 95p, 10 fig, 3 tab, 31 refs, 8 append.

Descriptors: *Computer models, *Water quality, *Data processing, *Model studies, Suspended sediment, Dissolved oxygen, *Path of pollutants, River flow, Streamflow, Simulation.

A Users Manual for the Lagrangian Transport Model (LTM) is presented. The LTM uses Lagrangian calculations that are based on a reference frame moving with the river flow. The Lagrangian reference frame eliminates the need to numerically solve the convective term of the convection-diffusion equation and provides significant numerical advantages over the more commonly used Eulerian reference frame. When properly applied, the LTM can simulate riverine transport and decay processes within the accuracy required by most water quality studies. The LTM is applicable to steady or unsteady one-dimensional unidirectional flows in fixed channels with tributary and lateral inflows. Application of the LTM is relatively simple and optional capabilities improve the model's convenience. Appendices give file formats and three example LTM applications that include the incorporation of the QUAL II water quality model's reaction kinetics into the LTM. (Author's abstract)
W89-04924

GEOLOGY OF THE SURFICIAL AQUIFER SYSTEM, DADE COUNTY, FLORIDA,
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-04925

HYDROGEOLOGY OF THE EASTERN PART OF THE SALT RIVER VALLEY AREA, MARICOPA AND PINAL COUNTIES, ARIZONA,
Geological Survey, Tucson, AZ. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-04926

LOUISIANA HYDROLOGIC ATLAS MAP NO. 1: MEAN ANNUAL RUNOFF IN LOUISIANA,
Geological Survey, Baton Rouge, LA. Water Resources Div.
H. C. McWreath, and A. S. Lowe.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, Co 80225. USGS Water Resources Investigations Report 86-4149. 1986. 1 sheet (map), 3 fig, 1 tab, 7 ref.

Descriptors: *Water resources data, *Streamflow data, *Maps, *Louisiana, *Runoff, *Stream discharge, *Annual runoff, Catchment areas, Sabine River, Red, River, Mermentau River.

The map shows the mean annual runoff from drainage basins in Louisiana exclusive of those in the coastal zone and the alluvial valleys of the Mississippi, Ouachita, and Red Rivers. The mean annual runoff for the State of Louisiana varies from 0.7 (cu ft/s)/sq mi in the Sabine and Red River basins to >2.0 (cu ft/s)/sq mi in the upper reaches of the Mermentau River. Factors that account for the three-fold variation in runoff across Louisiana include regional differences in rainfall, varying physical characteristics of the land, and differing land use patterns. The mean annual runoff was determined on the basis of continuing measurements of stage and discharge of uncontrolled streams. The periods of record from the 88 stations shown on the map vary from 5 to 25 yr. The 88 stations were grouped into seven categories of runoff. The boundaries for each region generally correspond to drainage boundaries or physiographic boundaries. (Peters-PTT)
W89-04927

LOUISIANA HYDROLOGIC ATLAS MAP NO. 2: AREAL EXTENT OF FRESHWATER IN MAJOR AQUIFERS OF LOUISIANA,
Geological Survey, Baton Rouge, LA. Water Resources Div.
C. W. Smoot.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, Co 80225. USGS Water Resources Investigations Report 86-4150. 1986. 1 sheet (map), 4 fig, 2 tab, 19 ref.

Descriptors: *Water resources data, *Geohydrology, *Groundwater resources, *Maps, *Aquifers, *Louisiana, *Water supply, *Potential water supply, Saline water, Saline-freshwater interfaces.

The areal availability of freshwater (cl content < 250 mg/L) in 14 major aquifers in Louisiana was investigated. The depth of occurrence of fresh groundwater in Louisiana is variable. The aquifers were mapped to show their areal extent from the outcrop or subcrop to the downdip limit of freshwater. Water in each aquifer becomes saline downdip; but in most areas an overlying (younger) aquifer contains freshwater. None of the major aquifer contains freshwater in northern Louisiana where the Vicksburg and Jackson groups crop out and the underlying Cockfield aquifer (Cockfield Formation) contains saline water. (Peters-PTT)
W89-04928

QUALITY OF WATER RESOURCES OF THE OUACHITA NATIONAL FOREST, ARKANSAS,
Geological Survey, Little Rock, AR. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-04938

SELECTED HYDROLOGIC AND PHYSICAL PROPERTIES OF MESOZOIC FORMATIONS IN THE UPPER COLORADO RIVER BASIN IN ARIZONA, COLORADO, UTAH, AND WYOMING--EXCLUDING THE SAN JUAN BASIN,
Geological Survey, Salt Lake City, UT. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-04940

WATER-LEVEL MAPS OF THE ALLUVIAL AQUIFER IN EASTERN ARKANSAS, 1985,
Geological Survey, Little Rock, AR. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-04948

TECHNIQUES FOR SIMULATING FLOOD HYDROGRAPHS AND ESTIMATING FLOOD VOLUMES FOR UNGAGED BASINS IN CENTRAL TENNESSEE,
Geological Survey, Nashville, TN. Water Resources Div.
For primary bibliographic entry see Field 2E.
W89-04955

THREE-DIMENSIONAL MODEL SIMULATION OF TRANSIENT GROUND-WATER FLOW IN THE ALBUQUERQUE-BELEN BASIN, NEW MEXICO,
Geological Survey, Albuquerque, NM. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-04957

DIRECTIONS AND RATES OF GROUND-WATER MOVEMENT IN THE VICINITY OF KESTERSON RESERVOIR, SAN JOAQUIN VALLEY, CALIFORNIA,
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-04958

ESTIMATING PEAK DISCHARGES, FLOOD VOLUMES, AND HYDROGRAPH SHAPES OF SMALL UNGAGED URBAN STREAMS IN OHIO,
Geological Survey, Columbus, OH. Water Resources Div.
For primary bibliographic entry see Field 2E.
W89-04959

DESCRIPTION AND COMPARISON OF SELECTED MODELS FOR HYDROLOGIC ANALYSIS OF GROUND-WATER FLOW, ST. JOSEPH RIVER BASIN, INDIANA,
Geological Survey, Indianapolis, IN. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-04961

WATER-TABLE CONTOURS AND DEPTH TO WATER IN THE SOUTHEASTERN PART OF THE SWEETWATER RIVER BASIN, CENTRAL WYOMING, 1982,
Geological Survey, Cheyenne, WY.
W. B. Borchert.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4205, 1987. 1p, (map), 6 ref.

Descriptors: *Wyoming, *Maps, *Aquifers, *Geohydrology, *Water table profiles, Streamflow, White River.

This map describes the southeastern part of the Sweetwater River basin; the major aquifer consists of the upper part of the White River formations, all of Tertiary age, and to a small extent, the alluvium of the Quaternary age along the Sweetwater River. The saturated thickness of the aquifer in most of the area, but not including the alluvium ranges from 500 to 3000 ft. The maximum saturated thickness of the alluvium penetrated by test holes was 63 ft. The water-table contours and depths to water are based primarily on groundwater-level measurements made during 1982 in 104 wells, most of which are located south of the Sweetwater River. Land-surface altitudes of springs and water-surface altitudes along the Sweetwater River and perennial reaches of creeks flowing northward from the Green and Ferris Mountains also were used as control for mapping the water table. The perennial reaches shown on the map are assumed hydraulically connected with the water table. They were identified from streamflow gain-and-loss measurements made during April and May 1982. (Author's abstract)
W89-04969

STREAMFLOW GAIN AND LOSS OF SELECTED STREAMS IN NORTHERN ARKANSAS,
Geological Survey, Little Rock, AR. Water Resources Div.
D. A. Freiwald.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4185, 1987. 4p (maps), 9 fig, 1 tab, 8 ref.

Descriptors: *Seepage, *Surface-groundwater relations, *Arkansas, *Maps, *Streamflow, *Low flow, Channel faults, Specific conductivity.

This map shows streamflow gain and loss measurements (seepage runs) on the Crooked, Osage, and Spavinaw Creeks, and Illinois, Kings, Mulberry, Spring, and Strawberry Rivers during the low-

flow conditions from September 1982 to October 1984. Data indicated that streamflow gains and losses resulted from differences in lithology of the predominately carbonate rocks and from the presence of faults. The Kings and Strawberry Rivers and Osage Creek were gaining streams throughout their length, however wastewater discharges precluded an accurate determination on Osage Creek. Crooked and Spavinaw Creeks and the Illinois, Spring, and Mulberry Rivers generally were gaining streams throughout most of their lengths although short losing reaches were identified. The largest gains in streamflow generally occurred were Mississippian formation predominated near the streams. Faults that intersected the stream channels primarily were responsible for streamflow losses. The specific conductance of water increased in the stream reaches that had the most significant streamflow gains. The specific conductance of water in tributaries was generally higher than that in larger streams. (Author's abstract)
W89-04970

APPLICATION OF AN EFFICIENT NONLINEAR REGRESSION TECHNIQUE FOR SEWER COST MODELLING,
National Univ. of Singapore. Dept. of Civil Engineering.
For primary bibliographic entry see Field 6B.
W89-05000

IMPROVEMENT TO THE ONE-STEP OUTFLOW METHOD FOR THE DETERMINATION OF SOIL WATER DIFFUSIVITIES,
Agricultural Coll. of Athens (Greece). Lab. of Agricultural Hydraulics.
For primary bibliographic entry see Field 2G.
W89-05060

USING EXOGENOUS VARIABLES IN TESTING FOR MONOTONIC TRENDS IN HYDROLOGIC TIME SERIES,
Geological Survey, Reston, VA.
For primary bibliographic entry see Field 2A.
W89-05065

USE OF CHANGE CONSTRAINTS IN RESERVOIR DESIGN AND OPERATION MODELING,
Wright State Univ., Dayton, OH. Dept. of Geology.
For primary bibliographic entry see Field 4A.
W89-05067

COMPARISON OF BULK, WET-ONLY, AND WET-PLUS-DRY DEPOSITION MEASUREMENTS AT THE TURKEY LAKES WATERSHED,
Atmospheric Environment Service, Downsview (Ontario).
For primary bibliographic entry see Field 5B.
W89-05084

MODELLING STREAM CHEMISTRY FOR THE TURKEY LAKES WATERSHED: COMPARISON WITH 1981-84 DATA,
Canada Centre for Inland Waters, Burlington (Ontario).
For primary bibliographic entry see Field 5B.
W89-05089

APPLICATION OF A HYDROLOGICAL MODEL TO THE ACIDIFIED TURKEY LAKES WATERSHED,
National Water Research Inst., Burlington (Ontario). Rivers Research Branch.
For primary bibliographic entry see Field 5B.
W89-05090

MULTIVARIATE ANALYSIS OF CORRELATIONS BETWEEN ENVIRONMENTAL PARAMETERS AND CADMIUM CONCENTRATIONS IN HYALELLA AZTECA (CRUSTACEA: AMPHIPODA) FROM CENTRAL ONTARIO LAKES,
Guelph Univ. (Ontario). Dept. of Zoology.
For primary bibliographic entry see Field 5B.
W89-05103

AGRICULTURAL CRITERIA FOR SUBSURFACE DRAINAGE: A SYSTEMS ANALYSIS,
International Inst. for Land Reclamation and Improvement, Wageningen (Netherlands).
For primary bibliographic entry see Field 4A.
W89-05115

DRAINAGE CRITERIA FOR HEAVY SOILS WITH A SHALLOW IMPERVIOUS LAYER,
Instituto Nacional de Reforma y Desarrollo Agrario, Madrid (Spain).
For primary bibliographic entry see Field 4A.
W89-05116

METHODS TO DETERMINE THE NEED FOR DRAINAGE IN FLAT AREAS,
Vizgazdalkodasi Tudomanyos Kutato Intezet, Budapest (Hungary).
For primary bibliographic entry see Field 4A.
W89-05117

FIELD DRAINAGE AND LAND MANAGEMENT: A COMPARISON OF FOUR LONG TERM FIELD TRIALS,
Birkbeck Coll., London (England). Dept. of Geography.
For primary bibliographic entry see Field 4A.
W89-05119

SIMPLE MODEL FOR FLOW ON HILLSLOPES,
New York State Coll. of Agriculture and Life Sciences, Ithaca. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 2E.
W89-05122

DESCRIPTION OF A REGIONAL GROUNDWATER FLOW MODEL SIMGRO AND SOME APPLICATIONS,
Institute for Land and Water Management Research, Wageningen (Netherlands).
For primary bibliographic entry see Field 2F.
W89-05127

EMPIRICAL APPROACH FOR PREDICTING RUNOFF YIELD UNDER DESERT CONDITIONS,
Ben-Gurion Univ. of the Negev, Sde Boker (Israel). Jacob Blaustein Inst. for Desert Research.
For primary bibliographic entry see Field 2E.
W89-05130

PREDICTION OF IRRIGATION SCHEDULING WITH THE NUMERICAL MODEL SWATRE,
Institute for Land and Water Management Research, Wageningen (Netherlands).
For primary bibliographic entry see Field 3F.
W89-05135

INFLUENCE OF SUB-SOIL ON THE MOISTURE REGIME IN IRRIGATED FIELDS,
Southampton Univ. (England). Inst. of Irrigation Studies.
For primary bibliographic entry see Field 2G.
W89-05136

FIELD VALIDATION OF AN EMPIRICAL SOIL WATER MODEL,
Imperial Coll. of Science and Technology, London (England). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2G.
W89-05137

CHANGE OF CHARACTERISTICS OF A GRANULAR AQUIFER IN AGRICULTURAL AREAS,
Calgary Univ. (Alberta). Dept. of Geology and Geophysics.
For primary bibliographic entry see Field 2F.
W89-05138

GROUNDWATER RECHARGE IN SCHLESWIG-HOLSTEIN (WEST GERMANY),
Kiel Univ. (Germany, F.R.). Inst. fuer Pflanzenernaehrung und Bodenkunde.
For primary bibliographic entry see Field 2F.
W89-05139

MODELLING FOREST WATER CONSUMPTION IN THE NETHERLANDS,
Groningen Rijksuniversiteit (Netherlands). Dept. of Physical Geography.
For primary bibliographic entry see Field 2D.
W89-05146

RELATIONSHIPS BETWEEN AIR TEMPERATURE, DEPTH, NUTRIENTS AND CHLOROPHYLL IN 103 ARGENTINIAN LAKES,
Instituto Nacional de Investigacion y Desarrollo Pesquero, Mar del Plata (Argentina). Dept. de Aguas Continentales.
For primary bibliographic entry see Field 2H.
W89-05158

RESPONSE OF THE PHYTOPLANKTON COMMUNITY TO THERAPY MEASURES IN A HIGHLY EUTROPHIC URBAN LAKE (SCHLACHTENSEE, BERLIN),
For primary bibliographic entry see Field 5G.
W89-05165

LAKES. 9. MODELS: MODELING WATER QUALITY IN RESERVOIR TAILWATERS,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
For primary bibliographic entry see Field 5G.
W89-05170

REGRESSION EQUATIONS FOR LAKE MANAGEMENT: HOW FAR DO THEY GO,
Senter for Industriforskning, Oslo (Norway).
For primary bibliographic entry see Field 5G.
W89-05171

APPLICATION OF THE ECOLOGICAL MODEL FINNECO TO LAKE GJERSJOEN,
Norsk Inst. for Vannforskning, Oslo.
For primary bibliographic entry see Field 5G.
W89-05172

PHYTOPLANKTON MODELLING BY MEANS OF OPTIMIZATION: A 10-YEAR EXPERIENCE WITH BLOOM II,
Waterloopkundig Lab. te Delft (Netherlands).
For primary bibliographic entry see Field 5G.
W89-05173

PARTIAL DESTRATIFICATION OF EUTROPHIC LAKES: A TOOL FOR 'ECOSYSTEM MODELLING',
Max-Planck-Inst. fuer Limnologie zu Ploen (Germany, F.R.).
For primary bibliographic entry see Field 2H.
W89-05175

SIMPLE MODEL TO PREDICT WATER QUALITY IN 90 JAPANESE LAKES,
National Inst. for Environmental Studies, Ibaraki (Japan).
For primary bibliographic entry see Field 2H.
W89-05176

PREDICTION OF (CHLOROPHYLL-A) IN IMPOUNDMENTS OF SHORT HYDRAULIC RETENTION TIME: MIXING EFFECTS,
Ministry of Works and Development, Hamilton (New Zealand). Water Quality Centre.
For primary bibliographic entry see Field 2H.

W89-05178

SERIAL DISCONTINUITY IN A LARGE RIVER SYSTEM,
Montana Univ., Polson. Flathead Lake Biological Station.
For primary bibliographic entry see Field 2E.
W89-05197

EFFECTS OF WATERSHED VEGETATION AND DISTURBANCE ON INVERTEBRATE COMMUNITY STRUCTURE IN WESTERN CASCADE STREAMS: IMPLICATIONS FOR STREAM ECOSYSTEM THEORY,
Utah State Univ., Logan. Dept. of Fisheries and Wildlife.
For primary bibliographic entry see Field 2H.
W89-05204

EFFECT OF WALLS IN MODELING FLOW THROUGH POROUS MEDIA,
Michigan State Univ., East Lansing. Dept. of Mechanical Engineering.
For primary bibliographic entry see Field 2F.
W89-05211

SIMULATION OF SUSPENDED SEDIMENT IN COLUSA BASIN DRAIN,
Pahlavi Univ., Shiraz (Iran).
For primary bibliographic entry see Field 2J.
W89-05221

INTERACTION OF MASS TRANSFER AND INHIBITION IN BIOFILMS,
Utah State Univ., Logan. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 5D.
W89-05226

ANAEROBIC BIODEGRADATION OF PHENOL: INHIBITION KINETICS AND SYSTEM STABILITY,
Illinois Univ., Urbana. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W89-05227

ASSESSMENT OF PROBABILITY DISTRIBUTION OF DISSOLVED OXYGEN DEFICIT,
Wyoming Univ., Laramie. Water Resources Research Inst.
For primary bibliographic entry see Field 5B.
W89-05231

UPDATED ASSESSMENT OF NATIONAL WEATHER SERVICE 30-DAY AND 90-DAY FORECASTS FOR NEW JERSEY,
Cook Coll., New Brunswick, NJ. Dept. of Meteorology and Physical Oceanography.
For primary bibliographic entry see Field 2B.
W89-05238

EMPIRICAL MODELS FOR TROPHIC STATE IN SOUTHEASTERN U.S. LAKES AND RESERVOIRS,
Duke Univ., Durham, NC. School of Forestry and Environmental Studies.
For primary bibliographic entry see Field 2H.
W89-05262

DECISION SUPPORT SYSTEM FOR SELECTING INPUTS TO A BASIN SCALE MODEL,
Agricultural Research Service, Temple, TX. Soil and Water Conservation Research Div.
For primary bibliographic entry see Field 7A.
W89-05265

INDEX FOR MEASURING THE PERFORMANCE OF IRRIGATION MANAGEMENT SYSTEMS WITH AN APPLICATION,
Colorado State Univ., Fort Collins. Dept. of Agricultural and Natural Resource Economics.
For primary bibliographic entry see Field 3F.

W89-05276

HYDROLOGIC MODELING USING A SIMULATION LANGUAGE BASED ON QUEUEING THEORY,
Agricultural Research Service, Temple, TX. Grassland, Soil and Water Research Lab.
J. G. Arnold, and J. R. Williams.
Water Resources Bulletin WARBAQ, Vol. 24, No. 4, p 861-868, August 1988. 6 fig, 6 tab, 14 ref.

Descriptors: *Model studies, *Rainfall-runoff relationships, *Hydrologic models, *Model studies, *Simulation, *Cumulative runoff, *Discharge hydrographs, Watersheds, Catchment areas, Watercourses, Flow rates, Hydrographs.

A novel approach has been developed by applying queueing theory to hydrologic modeling. A queueing situation is characterized by a flow of customers arriving randomly at one or more service facilities. In this case, the customers are represented by water and the service time is the time it takes to move through the soil and over the land. This approach has the potential to be simpler and more efficient than some previously developed models. Another important attribute of queueing theory is its ability to model almost unlimited detail. Many simulation languages based on queueing theory have been developed and tested and are available. Applications of the languages include manufacturing operations, transportation systems, computer systems, financial planning, and health care systems. A model was developed, using a simulation language, to predict runoff hydrographs from storms occurring on small homogeneous watersheds. With continued development, queueing theory could provide an efficient, detailed approach to simulating many natural processes. (Author's abstract)
W89-05277

PREDICTIVE CAPABILITIES OF BATCH-EXTRACT EXPERIMENTS USING WATER FROM A COAL MINE,
Geological Survey, Cheyenne, WY. Water Resources Div.
For primary bibliographic entry see Field 5B.
W89-05278

OPTIMIZING THE RETURN FROM A JOJOBA PLANTATION UNDER SCARCE DATA CONDITIONS,
Dead Sea Works, Beersheba (Israel).
For primary bibliographic entry see Field 3F.
W89-05279

MODEL OF TEMPERATURE INDUCED DENSITY CURRENT IN WATERSIDE REEDBELTS OF LAKE CONSTANCE-UNTERSEE (EIN STROMUNGSMODELL DER TEMPERATURINDUZIERTEN DICHTESTROMUNG IN GESCHLOSSENEN UFERROHRICHTEN DES BODENSEE-UNTERSEES),
Fachhochschule Konstanz (Germany, F.R.).
For primary bibliographic entry see Field 2H.
W89-05286

MATHEMATICAL MODEL OF THE CYCLONIC OPERATION OF DESALINATION-FEEDWATER SOFTENING BY ION-EXCHANGE WITH FLUIDIZED-BED REGENERATION,
California Univ., Berkeley. Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5D.
W89-05333

DREDGED MATERIAL DISPOSAL MODELING IN PUGET SOUND,
Waterways Experiment Station, Vicksburg, MS.
For primary bibliographic entry see Field 5E.
W89-05345

STOCHASTIC MODELS FOR FIRST-ORDER KINETICS OF BIOCHEMICAL OXYGEN DEMAND WITH RANDOM INITIAL CONDITIONS, INPUTS, AND COEFFICIENTS,
McGill Univ., Montreal (Quebec). Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W89-05346

NEW METHOD OF DESCRIBING BOTTOM STRESS IN TWO-DIMENSIONAL HYDRODYNAMICAL MODELS OF SHALLOW HOMOGENEOUS SEAS, ESTUARIES, AND LAKES,
Western Australia Univ., Nedlands. Centre for Water Research.
For primary bibliographic entry see Field 2H.
W89-05347

GROUND-WATER DATA FOR THE SALT BASIN, EAGLE FLAT, RED LIGHT DRAW, GREEN RIVER VALLEY, AND PRESIDIO BOLSON IN WESTERNMOST TEXAS,
Geological Survey, Austin, TX. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-05406

RECORDS OF WELLS, DRILLERS' LOGS, WATER-LEVEL MEASUREMENTS, AND CHEMICAL ANALYSES OF GROUND WATER IN BRAZORIA, FORT BEND, AND WALLER COUNTIES, TEXAS, 1980-84,
Geological Survey, Austin, TX. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-05415

RECORDS OF WELLS, DRILLERS' LOGS, WATER-LEVEL MEASUREMENTS, AND CHEMICAL ANALYSES OF GROUND WATER IN CHAMBERS, LIBERTY, AND MONTGOMERY COUNTIES, TEXAS, 1980-84,
Geological Survey, Austin, TX. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-05416

SUMMARY OF HYDROLOGIC INFORMATION IN THE EL PASO, TEXAS, AREA, WITH EMPHASIS ON GROUND-WATER STUDIES, 1903-80,
Geological Survey, Austin, TX. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-05417

DEVELOPMENT OF GROUND-WATER RESOURCES IN ORANGE COUNTY, TEXAS, AND ADJACENT AREAS, 1971-80,
Geological Survey, Austin, TX. Water Resources Div.
For primary bibliographic entry see Field 4B.
W89-05418

CHEMICAL AND PHYSICAL CHARACTERISTICS OF WATER IN ESTUARIES OF TEXAS, OCTOBER 1976-SEPTEMBER 1978,
Geological Survey, Austin, TX. Water Resources Div.
For primary bibliographic entry see Field 2L.
W89-05419

COMPUTER SIMULATION IN PHYSICAL GEOGRAPHY,
M. J. Kirkby, P. S. Naden, T.p. Burt, and D.p. Butcher.
John Wiley and Sons, New York. 1987. 227p.

Descriptors: *Computer programs, *Simulation analysis, *Geography, Hydrology, Geomorphology, Climatology, Model studies, Stochastic models.

Simulation modeling has grown in importance in geographical teaching and project work as microcomputers have become more readily available. By developing a wide range of usable programs in an

environmental context, this book provides a means both of teaching physical geography using microcomputers and of teaching BASIC programming with geographical examples. Examples are drawn from hydrology, geomorphology, biogeography and climatology, and are used to illustrate different approaches to modeling and how to build rationally based computer simulations from geographical assumptions. The book opens with an introduction to the subject, followed by a series of chapters, each of which is devoted to a different type of model, including black box models, process models, mass and energy balance models and stochastic models. These model types are applied to kinematic waves for gravel bed load, channel network simulations, prediction of runoff, prediction of evapotranspiration, analysis of erosion processes and a simple landslide model, among others. Program listings are included for relevant examples together with references to the geographical basis of the simulations. The second half of the book contains methods of model or program formulation and various means of verifying and calibrating models against field data. The choice of an appropriate model for a given situation is also considered. The programs are written in a standard subset of BASIC, and disks of the programs are available for both IBM and BBC microcomputers. (Lantz-PTT)
W89-05428

GROUNDWATER FLOW AND QUALITY MODELLING.
For primary bibliographic entry see Field 2F.
W89-05465

EIGENVALUES APPROACH FOR SOLVING LINEAR GROUNDWATER FLOW PROBLEMS,
Universidad Politecnica de Valencia (Spain).
For primary bibliographic entry see Field 2F.
W89-05474

NEW METHOD FOR DIFFUSIVE TRANSPORT,
Universidad Nacional Autonoma de Mexico, Mexico City. Inst. de Geofisica.
For primary bibliographic entry see Field 2F.
W89-05475

COMPARISON OF FAST EQUATION SOLVERS FOR GROUNDWATER FLOW PROBLEMS,
Ruhr Univ., Bochum (Germany, F.R.).
For primary bibliographic entry see Field 2F.
W89-05476

MODELLING FLOW AND TRANSPORT THROUGH POROUS MEDIA ON VECTOR COMPUTERS,
Technische Hochschule Aachen (Germany, F.R.). Lehrstuhl fuer Wasserbau und Wasserwirtschaft und Inst. fuer Wasserbau.
A. Peters, and W. Pelka.
IN: Groundwater Flow and Quality Modelling. D. Reidel Publishing Co., Boston. 1988. p 189-200, 10 fig, 1 tab, 13 ref. German Research Foundation (DFG) Grant Ro 356/27.

Descriptors: *Vector computers, *Model studies, *Model studies, *Groundwater movement, *Computers, *Porous media, *Solute transport, Mathematical equations, Groundwater budget, Groundwater quality, Finite element method.

This is a survey of some work recently done in an attempt to construct a finite element system for high performance vector computers. Based mainly on primitive elements, with a linear integration law, the system consists of efficient and reliable algorithms working on data structures as a whole. The system has already been implemented on a CRAY X-MP and on a CDC-CYBER 205 and used in some practical studies concerning groundwater quantity and quality problems. (See also W89-05465) (Author's abstract)
W89-05477

EULERIAN-LAGRANGIAN METHOD FOR SOLVING TRANSPORT IN AQUIFERS,
Technion - Israel Inst. of Tech., Haifa.
S. Sorek.
IN: Groundwater Flow and Quality Modelling. D. Reidel Publishing Co., Boston. 1988. p 201-214, 14 fig, 8 ref.

Descriptors: *Model studies, *Solute transport, *Eulerian-Lagrangian equations, *Groundwater movement, *Mathematical models, *Simulation analysis, Heterogeneity, Groundwater recharge, Precipitation, Aquifers, Advection.

A Eulerian-Lagrangian scheme is used to reformulate the equation of solute transport with groundwater in saturated soils. The governing equation is decomposed into advection along characteristic path lines and propagation of the residue at a fixed grid. The method was employed to simulate transport of a conservative pollutant in a hypothetical aquifer, subject to the equivalence of real conditions. Implementation was based on data involving parameters of a heterogeneous aquifer, heavy flux stresses of densed pumpage/recharge wells, precipitation and seasonally changing flow regimes. Simulation, with coarse grid and high Peclet numbers yielded minute mass balance errors. (See also W89-05465) (Author's abstract)
W89-05478

HYDRODYNAMIC DISPERSION IN MODEL POROUS MEDIA,
Thessaloniki Univ., Salonika (Greece). School of Technology.
J. G. Ganoulis.
IN: Groundwater Flow and Quality Modelling. D. Reidel Publishing Co., Boston. 1988. p 215-226, 7 fig, 11 ref.

Descriptors: *Dispersion, *Hydrodynamics, *Model studies, *Groundwater movement, *Porous media, *Solute transport, Mathematical equations, Convection, Diffusion, Finite element analysis.

The mass transport of a solute in laminar flow through spatially periodic porous media is studied. These are composed of cylinders of square or circular cross sections in parallel rows. The objective is to analyze the convective diffusion in the pore and laboratory scales and determine the nature of the macroscopic dispersion coefficients. Finite differences and finite elements are used to integrate the Navier-Stokes and the convective diffusion equations. The reliability of the computations is checked for some cases by performing laboratory experiments. Small variations from the Fickian law for the solute concentrations are found at the macroscopic scale for low Reynolds number. These are larger at higher Reynolds numbers when laminar eddies and flow separation occur. (See also W89-05465) (Author's abstract)
W89-05479

RANDOM WALK METHOD IN POLLUTANT TRANSPORT SIMULATION,
Stuttgart Univ. (Germany, F.R.). Inst. fuer Wasserbau.
For primary bibliographic entry see Field 5B.
W89-05480

MODELING OF SOLUTE TRANSPORT WITH THE RANDOM WALK METHOD,
Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands).
For primary bibliographic entry see Field 5B.
W89-05481

MODELLING OF FLOW THROUGH FRACTURED ROCKS: GEOSTATISTICAL GENERATION OF FRACTURE NETWORKS, STRESS-FLOW RELATIONSHIP IN FRACTURES,
Bureau de Recherches Geologiques et Minieres, Orleans (France).
For primary bibliographic entry see Field 2F.
W89-05482

COMBINED SEISMIC AND HYDRAULIC METHOD OF MODELING FLOW IN FRACTURED LOW PERMEABILITY ROCKS,
California Univ., Berkeley. Dept. of Mathematics.
For primary bibliographic entry see Field 2F.
W89-05483

STOCHASTIC CONTINUUM REPRESENTATION OF FRACTURED ROCK PERMEABILITY AS AN ALTERNATIVE TO THE REV AND FRACTURE NETWORK CONCEPTS,
Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.
For primary bibliographic entry see Field 2F.
W89-05484

FLOW IN THREE-DIMENSIONAL FRACTURE NETWORKS USING A DISCRETE APPROACH,
Cornell Univ., Ithaca, NY. Dept. of Environmental Engineering.
For primary bibliographic entry see Field 2F.
W89-05485

MINC: AN APPROACH FOR ANALYZING TRANSPORT IN STRONGLY HETEROGENEOUS SYSTEMS,
California Univ., Berkeley. Lawrence Berkeley Lab.
For primary bibliographic entry see Field 2F.
W89-05486

STOCHASTIC PARTICLE TRANSPORT MODEL BASED ON DIRECTIONAL STATISTICS OF FLOW THROUGH FRACTURE NETWORKS,
Quebec Univ., Chicoutimi.
For primary bibliographic entry see Field 2F.
W89-05487

ADVANCES IN MODELLING WATER-ROCK INTERACTION IN AQUIFERS,
Kiel Univ. (Germany, F.R.). Geologisch-Palaeontologisches Inst. und Museum.
For primary bibliographic entry see Field 2F.
W89-05488

PARAMETERS FOR MODELLING THE TRANSPORT OF CADMIUM AS INFLUENCED BY THE CHEMICAL PROPERTIES OF GROUND WATER AND AQUIFER MATERIAL,
Kiel Univ. (Germany, F.R.). Geologisch-Palaeontologisches Inst. und Museum.
For primary bibliographic entry see Field 5B.
W89-05489

MICRO-SCALE MODELLING IN THE STUDY OF PLUME EVOLUTION IN HETEROGENEOUS MEDIA,
Waterloo Univ. (Ontario). Inst. for Ground Water Research.
For primary bibliographic entry see Field 5B.
W89-05490

MODELLING THE INCREASING DISPERSIVITY WITH FE TRANSPORT MODELS USING THE MULTILAYER CONCEPT,
Karlsruhe Univ. (Germany, F.R.). Inst. fuer Hydromechanik.
For primary bibliographic entry see Field 5B.
W89-05491

RANDOM-WALK METHOD TO SIMULATE POLLUTANT TRANSPORT IN ALLUVIAL AQUIFERS OR FRACTURED ROCKS,
Strasbourg-1 Univ. (France). Inst. de Mechanique des Fluides.
For primary bibliographic entry see Field 5B.
W89-05492

ADVANCES IN MODELING OF WATER IN THE UNSATURATED ZONE,
Princeton Univ., NJ. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2G.
W89-05493

ESTIMATION OF SPATIAL COVARIANCE STRUCTURES WITH APPLICATION TO HYDROLOGICAL, HYDROCHEMICAL AND ISOTOPIC DATA FROM AQUIFERS: STATE-OF-THE-ART AND ADJOINT STATE MAXIMUM LIKELIHOOD CROSS-VALIDATION METHODS,
Universidad Politecnica de Madrid (Spain). Escuela Tecnica Superior de Ingenieros de Caminos.
For primary bibliographic entry see Field 2F.
W89-05497

PRESENT LIMITATIONS AND PERSPECTIVES ON MODELING POLLUTION PROBLEMS IN AQUIFERS,
Geological Survey, Reston, VA.
For primary bibliographic entry see Field 5B.
W89-05499

ADVANCES IN THE ASSESSMENT OF DATA WORTH FOR ENGINEERING DECISION ANALYSIS IN GROUNDWATER CONTAMINATION PROBLEMS,
British Columbia Univ., Vancouver. Dept. of Geological Sciences.
For primary bibliographic entry see Field 5B.
W89-05500

COMPARATIVE ANALYSIS OF MATHEMATICAL MASS TRANSPORT CODES FOR GROUNDWATER POLLUTION STUDIES,
Laboratorio Nacional de Engenharia Civil, Lisbon (Portugal).
For primary bibliographic entry see Field 5B.
W89-05501

NEW APPROACHES AND APPLICATIONS IN SUBSURFACE FLOW MODELING: 3-D FINITE ELEMENT ANALYSIS OF DEWATERING FOR AN ELECTRO-NUCLEAR PLANT,
Padua Univ. (Italy). Inst. of Applied Mathematics.
For primary bibliographic entry see Field 8A.
W89-05502

LARGE SCALE 3-D GROUNDWATER FLOW MODELLING IN HIGHLY HETEROGENEOUS GEOLOGIC MEDIUM,
Neuchatel Univ. (Switzerland). Center of Hydrology.
For primary bibliographic entry see Field 2F.
W89-05503

PRESENT STATE OF COASTAL AQUIFER MODELLING: SHORT REVIEW,
Universidad Politecnica de Cataluna, Barcelona (Spain). Escuela Tecnica Superior de Ingenieros de Caminos, Canales y Puertos.
For primary bibliographic entry see Field 2F.
W89-05505

PREDICTIVE ASSESSMENT OF THE MIGRATION OF LEACHATE IN THE SUBSOILS SURROUNDING MINE TAILINGS AND DREDGING SPOIL SITES,
Laboratorium voor Grondmechanica, Delft (Netherlands).
For primary bibliographic entry see Field 5B.
W89-05569

PRE-MINE PREDICTION OF ACID MINE DRAINAGE,
Environmental Protection Service, Vancouver (British Columbia).
For primary bibliographic entry see Field 5B.
W89-05570

COMPARISON OF TWO STREAM-DISCHARGE RECORD RECONSTRUCTION TECHNIQUES FOR EIGHT GAGING STATIONS IN MAINE,
For primary bibliographic entry see Field 2E.
W89-05595

COMPARISON OF VELOCITY INTERPOLATION METHODS FOR COMPUTING OPEN-CHANNEL DISCHARGE,
For primary bibliographic entry see Field 7B.
W89-05598

PRELIMINARY EVALUATION OF A DISCHARGE COMPUTATION TECHNIQUE THAT USES A SMALL NUMBER OF VELOCITY OBSERVATIONS,
For primary bibliographic entry see Field 2E.
W89-05599

STATISTICAL ANALYSIS OF FLOODS AND REGIONAL RELATIONS,
Politechnika Warszawska (Poland). Inst. of Environmental Engineering.
For primary bibliographic entry see Field 2E.
W89-05623

COMBINED REGIONAL FLOOD FREQUENCY ANALYSIS AND REGRESSION ON CATCHMENT CHARACTERISTICS BY MAXIMUM LIKELIHOOD ESTIMATION,
Institute of Hydrology, Wallingford (England).
For primary bibliographic entry see Field 2E.
W89-05624

SIGNIFICANCE TEST FOR HOMOGENEITY OF FLOOD FREQUENCY REGIONS,
Geomorphological Services Ltd., Newport Pagnell (England).
For primary bibliographic entry see Field 2E.
W89-05626

TESTING THE SUITABILITY OF THE TWO-COMPONENT EXTREME VALUE DISTRIBUTION FOR REGIONAL FLOOD ESTIMATION,
Institute of Hydrology, Wallingford (England).
For primary bibliographic entry see Field 2E.
W89-05627

METHOD FOR ESTIMATING THE PEAK DISCHARGE THROUGH THE RECORDS OF MEAN DAILY DISCHARGE,
Florence Univ. (Italy).
For primary bibliographic entry see Field 2E.
W89-05628

OBSERVATION AND ANALYSIS OF FLOOD DISCHARGES: EXPERIENCES FROM SWITZERLAND,
Service Hydrologique National, Bern (Switzerland).
For primary bibliographic entry see Field 2E.
W89-05629

ESTIMATING THE REGULATORY FLOOD ON A DEGRADING RIVER,
Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.
For primary bibliographic entry see Field 2E.
W89-05630

COMPARISON OF REGIONAL FLOOD FREQUENCY METHODS IN SOUTHERN ONTARIO USING ANALYSIS OF VARIANCE TECHNIQUES,
Environment Canada, Ottawa (Ontario). Water Resources Branch.
For primary bibliographic entry see Field 2E.
W89-05631

COMPARISON OF FLOOD FREQUENCY CURVES FOR MANY DIFFERENT REGIONS OF THE WORLD,
Institute of Hydrology, Wallingford (England). Overseas Consultancy Group.
For primary bibliographic entry see Field 2E.
W89-05632

TWO-COMPONENT EXTREME VALUE DISTRIBUTION AND ITS POINT AND REGIONAL ESTIMATORS,
Universita di Reggio Calabria, Cosenza (Italy). Dipt. di Difesa del Suolo.
For primary bibliographic entry see Field 2E.
W89-05633

HISTORICAL FLOOD FREQUENCY DATA: ITS VALUE AND USE,
Cornell Univ., Ithaca, NY. Dept. of Environmental Engineering.
For primary bibliographic entry see Field 2E.
W89-05634

PALEOHYDROLOGIC DATA AND FLOOD FREQUENCY ESTIMATION,
Bureau of Reclamation, Denver, CO. Engineering and Research Center.
For primary bibliographic entry see Field 2E.
W89-05635

100-YEAR FLOOD,
Arizona Univ., Tucson. Dept. of Civil Engineering and Engineering Mechanics.
For primary bibliographic entry see Field 2E.
W89-05636

CHANGES IN HYDROLOGIC CONDITIONS RELATED TO LARGE FLOODS ON THE ESCALANTE RIVER, SOUTH-CENTRAL UTAH,
Geological Survey, Tucson, AZ.
For primary bibliographic entry see Field 2E.
W89-05637

PALEOFLOOD HYDROLOGIC ANALYSIS AT UNGAGED SITES, CENTRAL AND NORTHERN AUSTRALIA,
Arizona Univ., Tucson. Dept. of Geosciences.
For primary bibliographic entry see Field 2E.
W89-05638

HYDROLOGIC FREQUENCY MODELING: PROCEEDINGS OF THE INTERNATIONAL SYMPOSIUM ON FLOOD FREQUENCY AND RISK ANALYSES, 14-17 MAY 1986, LOUISIANA STATE UNIVERSITY, BATON ROUGE, U.S.A.
For primary bibliographic entry see Field 2E.
W89-05642

HYDROLOGICAL AND ENGINEERING RELEVANCE OF FLOOD FREQUENCY ANALYSIS,
Geological Survey, Reston, VA.
For primary bibliographic entry see Field 2E.
W89-05643

STATISTICAL FLOOD FREQUENCY ANALYSIS - AN OVERVIEW,
Delhi Coll. of Engineering (India).
For primary bibliographic entry see Field 2E.
W89-05644

REVIEW OF STATISTICAL MODELS FOR FLOOD FREQUENCY ESTIMATION,
University Coll., Galway (Ireland). Dept. of Engineering Hydrology.
For primary bibliographic entry see Field 2E.
W89-05646

ESTIMATION OF FLOOD FREQUENCIES BY A NONPARAMETRIC DENSITY PROCEDURE,
Ottawa Univ. (Ontario). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W89-05647

STATISTICAL MODELS FOR FLOOD FREQUENCY ESTIMATION OF THE MISSISSIPPI AND YAZOO RIVERS,
University of Southern Mississippi, Hattiesburg. Dept. of Economics.
For primary bibliographic entry see Field 2E.
W89-05648

PARTIAL DURATION SERIES WITH LOG-NORMAL DISTRIBUTED PEAK VALUES,
Technical Univ. of Denmark, Lyngby. Inst. of Hydrodynamics and Hydraulic Engineering.
For primary bibliographic entry see Field 2E.
W89-05649

ESTIMATION OF A PRIOR DISTRIBUTION FOR THE BAYESIAN ESTIMATION OF PEARSON III SKEWS,
Utah Univ., Salt Lake City. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W89-05650

COMPARISON OF FLOOD-FREQUENCY ESTIMATES BASED ON OBSERVED AND MODEL-GENERATED PEAK FLOWS,
Geological Survey, Reston, VA. Water Resources Div.
For primary bibliographic entry see Field 2E.
W89-05651

FLOOD FREQUENCY ANALYSIS USING BOX-COX TRANSFORMATION BASED GUMBEL EV-I DISTRIBUTION,
National Inst. of Hydrology, Roorkee (India).
For primary bibliographic entry see Field 2E.
W89-05652

FLOOD-FREQUENCY ANALYSIS WITH HISTORICAL DATA IN CHINA,
Geological Survey, Atlanta, GA. Water Resources Div.
For primary bibliographic entry see Field 2E.
W89-05653

DEVELOPMENT OF A VERSATILE FLOOD FREQUENCY METHODOLOGY AND ITS APPLICATION TO FLOOD SERIES FROM DIFFERENT COUNTRIES,
Illinois State Water Survey Div., Champaign.
For primary bibliographic entry see Field 2E.
W89-05654

HYDROCLIMATICALLY-DEFINED MIXED DISTRIBUTIONS IN PARTIAL DURATION FLOOD SERIES,
Louisiana State Univ., Baton Rouge. Dept. of Geography and Anthropology.
For primary bibliographic entry see Field 2E.
W89-05655

MIXED FLOOD DISTRIBUTIONS IN WISCONSIN,
Wisconsin Univ., Madison. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 2E.
W89-05656

FLOOD DATA, UNDERLYING DISTRIBUTION, ANALYSIS, AND REFINEMENT,
Illinois State Water Survey Div., Champaign.
For primary bibliographic entry see Field 2E.
W89-05657

VERY LOW PROBABILITY PRECIPITATION-FREQUENCY ESTIMATES: A PERSPECTIVE,
National Weather Service, Silver Spring, MD. Office of Hydrology.
For primary bibliographic entry see Field 2B.
W89-05658

SQRT-EXPONENTIAL TYPE DISTRIBUTION OF MAXIMUM,
Kinki Univ., Higashiosaka (Japan). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2B.
W89-05659

PROBABILISTIC CHARACTERISTICS OF POINT AND AREAL RAINFALL,
Nagoya Univ. (Japan). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2A.
W89-05660

COMPARISON OF THREE METHODS OF ESTIMATING RAINFALL FREQUENCY PARAMETERS ACCORDING TO THE DURATION OF ACCUMULATION,
University of Southern Mississippi, Long Beach.
For primary bibliographic entry see Field 2A.
W89-05661

FREQUENCY ANALYSIS OF AUSTRALIAN RAINFALL DATA AS USED FOR FLOOD ANALYSIS AND DESIGN,
Bureau of Meteorology, Melbourne (Australia). Hydrology Branch.
For primary bibliographic entry see Field 2B.
W89-05662

ANALYSIS OF FLOOD OCCURRENCE THROUGH CHARACTERIZATION OF PRECIPITATION PATTERNS,
Kyushu Univ., Fukuoka (Japan). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W89-05665

SAMPLING THEORY OF THE BINARY RANDOM FIELD DECIDES THE RELATION ABOUT POINT AND PLANE OF THE EXTRA RAINSTORMS,
Yanbian Water Conservancy and Water Electricity Survey Designing Inst. (China).
For primary bibliographic entry see Field 2B.
W89-05666

SOME NEW PERSPECTIVES ON MAXIMUM ENTROPY TECHNIQUES IN WATER RESOURCES RESEARCH,
Naval Research Lab., Washington, DC.
A. K. Rajagopal, S. Teitler, and V. P. Singh.
IN: Hydrologic Frequency Modeling: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 347-365, 28 ref.

Descriptors: *Entropy, *Statistics, *Statistical analysis, *Probabilistic process, Random variables, Density function, Kullback-Leibler, Parametric hydrology.

For continuous random variables, the principle of maximum entropy (POME) (and minimum Kullback-Leibler, KL, information) probability density function (pdf) belongs to the exponential family. They are a subset of pdf's with sufficient statistics. The latter just correspond to the constraints that enter into POME. Specifying the constraints is tantamount to specifying the probability model to be used in the analysis of data. If there is a sufficient statistic then the maximum likelihood estimate is a function of that statistic, but the maximum likelihood estimate is not necessarily a sufficient statistic. Essentially all the models employed in practice can be viewed as resulting from POME. In this sense, POME provides a unifying view for the statistical analysis. The ideas of transformation of the random variables along with POME lends some new insight. This introduces a novel flexibility in the description of changes under transformations and in dealing with data sets characterized by parameters that vary from set to set. Mean logarithmic decrement associated with a probability distribution is related to the concept of differential entropy. (See also W89-05642) (Davis-PTT)
W89-05667

ENTROPY AND PROBABILITY DISTRIBUTIONS,
Lanzhou Univ. (China).
Y. Li, V. P. Singh, and S. Cong.
IN: Hydrologic Frequency Modeling: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 367-382, 5 tab, 14 ref.

Descriptors: *Entropy, *Statistics, *Monte Carlo method, *Pearson distribution, *Statistical analysis, *Parametric hydrology, *Flood frequency, *Probability distribution, Entropy, Mathematical studies.

Entropy was employed to investigate probability distribution functions and estimation of their parameters for hydrologic analysis. Two curve fitting methods, one of which is based on entropy, were compared using Monte Carlo simulation. The principle of maximum entropy provides a unified framework for derivation of a number of probability distributions used in hydrology. Using Monte Carlo simulation for log-Pearson type 3 distribution, it was shown that the entropy method is better or at least comparable to the ordinary curve fitting method. The entropy method can be used to choose among probability distributions. (See also W89-05642) (Davis-PTT)
W89-05668

EVALUATION OF SEVEN METHODS FOR ESTIMATING PARAMETERS OF EVI DISTRIBUTION,
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
K. Arora, and V. P. Singh.
IN: Hydrologic Frequency Modeling: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 383-394, 4 tab, 10 ref.

Descriptors: *Probability distribution, *Statistics, *Correlation analysis, *Statistical analysis, *Flood frequency, Parametric hydrology, Mathematical studies, Monte Carlo method, Entropy, Estimating equations.

Extreme value type 1 distribution parameters and quantiles were estimated by methods of moments, maximum likelihood estimation, probability weighted moments, entropy, mixed moments, least squares and incomplete means for Monte Carlo samples generated from two sampling cases: purely random process and serially correlated process. The performance of these estimators was statistically evaluated. The methods of maximum likelihood estimation and entropy provided most efficient quantile estimates. The methods of moments and probability weighted moments were comparable in efficiency of estimating the quantiles for small samples. The methods of mixed moments and incomplete means resulted in poor estimation of parameters and the quantiles. The method of least squares provided minimum bias and maximum efficiency estimate of the parameter a for very small samples and also provided competitive estimates of the parameter b. For small samples, the method of probability weighted moments and the method of moments performed comparably in efficiency of estimating the quantiles. However,the efficiency of probability weighted moments somewhat improved relative to the method of maximum likelihood estimation with increasing sample size. The incorporation of serial correlation in samples resulted in deterioration of the performance of all estimators. However, all the methods performed much more similarly in this case. (See also W89-05642) (Davis-PTT)
W89-05669

FITTING LOG PEARSON TYPE 3 DISTRIBUTION BY MAXIMUM LIKELIHOOD,
Saint Johns River Water Management District, Palatka, FL.
D. V. Rao.
IN: Hydrologic Frequency Modeling: Proceedings

of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 395-406, 4 tab, 8 ref.

Descriptors: *Probability distribution, *Pearson distribution, *Statistical analysis, *Flood forecasting, *Log Pearson fit, Monte Carlo method, Outliers, Inliers, Maximum likelihood estimates.

Problems encountered in finding a maximum likelihood solution for log Pearson type 3 distribution were investigated. For a given sample at least two solutions were obtained, one with an upper bound and the other with a lower bound. In most cases the best solution was obvious from a comparison of sample statistics with the maximum likelihood estimates of statistical parameters, mean and variance. When these estimates differed greatly from the sample statistics, the sample contained either outliers or the solution was not satisfactory from a practical standpoint. Monte Carlo tests show that, in general, the maximum likelihood method may not give satisfactory Log Pearson fit for small samples. (See also W89-05642) (Author's abstract)
W89-05670

ESTIMATING THE PARAMETERS OF THE GENERALIZED GAMMA DISTRIBUTION BY MIXED MOMENTS,
Asian Inst. of Tech., Bangkok (Thailand).
H. N. Phien, T. V. N. Van, and J.-H. Kuo.
IN: Hydrologic Frequency Modeling: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 407-418, 2 tab, 14 ref.

Descriptors: *Gamma distribution, *Flood frequency, *Frequency analysis, *Statistical analysis, *Flood forecasting, Maximum likelihood estimates, Mathematical studies, Probability distribution.

Having three parameters but many possible forms, the generalized gamma (GG) distribution can be a good candidate for flood frequency analysis. Four methods of parameter estimation were introduced, and the sampling variances and covariances of the parameter estimators were analytically derived along with the variance of the T-year flood event. For 45 sets of annual flood data taken from different sources, the GG distribution provided good fits when these methods were employed. It was also found that although the sampling variances of the estimators were high, the percent standard error of the T-year flood was relatively small. Use of the GG distribution and these methods provide good design flood magnitudes at appropriately determined return periods. Even at a level as low as 10%, fitting these sets of annual flood data was accepted for at least two among the four methods of mixed moments. (See also W89-05642) (Davis-PTT)
W89-05671

ENTROPY PRINCIPLE IN THE ESTIMATION OF GUMBEL PARAMETERS,
Delhi Coll. of Engineering (India). Dept. of Civil Engineering.
A. Kumar, B. P. Parida, and R. Devi.
IN: Hydrologic Frequency Modeling: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 419-431, 4 tab, 16 ref.

Descriptors: *Entropy, *Frequency analysis, *Statistical analysis, *Flood frequency, Maximum likelihood estimates, Mathematical studies, Probability distribution.

The performance of the principle of maximum entropy (POME) in the estimation of Gumbel parameters was compared with four existing procedures: the method of moments, the principle of maximum likelihood, the method of least squares, and the probability weighted moments (PWM). Simulation studies compare the parameters and flood quantile bias. POME compared favorably with the PWM and performed better than the other methods. For small sample size, the performance of POME is significantly better than the method of moments and the method of least squares and comparable to the method of PWM. The potential of POME increases as it can be used in estimating the quantiles of Pearson or log Pearson distributions which are not amenable to the PWM. (See also W89-05642) (Davis-PTT)
W89-05672

ASSESSMENT OF USE OF AT-SITE AND REGIONAL FLOOD DATA FOR FLOOD FREQUENCY ESTIMATION,
University Coll., Galway (Ireland). Dept. of Engineering Hydrology.
C. S. Hebson, and C. Cunnane.
IN: Hydrologic Frequency Modeling: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 433-448, 2 fig, 6 tab, 19 ref.

Descriptors: *Frequency analysis, *Regional analysis, *Statistical analysis, *Flood frequency, Maximum likelihood estimates, Mathematical studies, Probability distribution, England.

The standard error of flood quantiles estimated by three different methods were obtained by simulation. The methods were based on at-site data, at-site and regional data combined, and regional data alone. Since the third method involves a regional regression relation an element of physical realism was preserved by basing the generating distributions on those estimated from real data of rivers in Southeast England by using the corresponding catchment characteristic values in regional regression relations. Mean floods were estimated from simulated at-site data of varying record lengths (1, 3, 6, and 10 yr) and from a regression model relating the mean to catchment characteristics. Three different stations (high, medium, and low Cv) and three different regions (uniform Cs and Cv, uniform Cs, and variable Cs and Cv) were considered. For the regional probability weighted moments technique even one year of data is to be preferred over a mean estimated from regional catchment characteristics. The at-site/regional method is considerably better than either at-site data alone or regional data alone, especially at high return periods. In general, the mean annual flood obtained by regional regression is less precise than data obtained from one year of record. (See also W89-05642) (Davis-PTT)
W89-05673

EMPIRICAL STUDY OF PROBABILITY DISTRIBUTIONS OF ANNUAL MAXIMUM FLOODS,
Purdue Univ., Lafayette, IN. School of Civil Engineering.
A. R. Rao, and P. S. Arora.
IN: Hydrologic Frequency Modeling: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 449-466, 3 fig, 8 tab, 17 ref.

Descriptors: *Wakeby distribution, *Pearson distribution, *Frequency analysis, *Statistical analysis, *Flood frequency, *Probability distribution, *Log pearson fit, Maximum likelihood estimates, Mathematical studies.

The Wakeby distribution has been proposed for flood frequency analysis because of its attractive properties. Annual maximum data from 25 watersheds have been analyzed by using the log pearson type III, mixture of extreme values and Wakeby distributions. The data are from watersheds in the United States and Europe and cover a variety of climatic conditions. The parameters of the distributions were estimated by the maximum likelihood method or the method of moments and the fitted distributions are compared to the histograms of the observed data by using the goodness of fit tests. In several instances, the log pearson type III distribution estimates failed to converge. The log pearson type III distribution underpredicts estimated flood values for both the low and high return periods. The mixed double exponential distribution overpredicts the estimated values for low return periods, compared to the log pearson III and Wakeby distributions. The performance of the Wakeby distribution was, in general, as good as that of the log pearson type III distribution and in some cases superior. The Wakeby distribution neither consistently underpredicts nor overpredicts estimated values for either low or high periods of floods, compared to the log pearson type III and mixed double exponential distributions. The Wakeby distribution based on the Psi test results is superior for flood frequency analysis compared to the log pearson III and Mixed double exponential distributions. The Wakeby distribution should be strongly considered for flood frequency analysis, especially since it is so easy to use. (See also W89-05642) (Davis-PTT)
W89-05674

COMPARISON OF SOME FLOOD FREQUENCY DISTRIBUTIONS USING EMPIRICAL DATA,
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
D. Jain, and V. P. Singh.
IN: Hydrologic Frequency Modeling: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 467-485, 8 tab, 14 ref.

Descriptors: *Frequency analysis, *Statistical analysis, *Flood frequency, *Probability distribution, *Log pearson fit, *Pearson distribution, Maximum likelihood estimates, Mathematical studies.

The Gumbel, 3-parameter log normal, Pearson type 3, log-Pearson type 3, and Boughton distributions as well as power transformation were evaluated and compared using 55 flood data sets from various sizes of drainage basins representing various parts of the United States. No distribution was found to fit all flood data sets accurately. Based on empirical criteria, the log-Pearson type 3 distribution emerged as the best distribution. (See also W89-05642) (Author's abstract)
W89-05675

USE OF HISTORICAL DATA IN FLOOD-FREQUENCY ANALYSIS,
Centro de Pesquisas de Energia Eletrica, Rio de Janeiro (Brazil).
J. M. Damazio, and J. Kelman.
IN: Hydrologic Frequency Modeling: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 487-497, 2 fig, 5 tab, 7 ref.

Descriptors: *Frequency analysis, *Statistical analysis, *Flood frequency, Maximum likelihood estimates, Mathematical studies, Probability distribution, Flood forecasting, Monte Carlo methods.

An assessment of several flood frequency procedures for the estimation of 10,000 yr of flood data is presented. Historical information such as the known maximum flow in a period of 100 yr was used in the analysis. Monte Carlo experiments are used to identify the accurate procedures. The two parameter distributions yielded better results than the three parameter distributions. Adjusting only two parameters avoids the influence of the highly unstable sample skewness. The expected errors of estimates can grow with the quantity of available information when distributions are used that are different from the population. The identification of the population is usually precarious. The alternative is to choose a distribution that is able to estimate without strong loss of efficiency, disregarding the population. The use of the exponential distribution is favored. (See also W89-05642) (Davis-PTT)
W89-05676

1983 IGUACU RIVER FLOOD: EFFECT OF A RARE FLOOD ON FREQUENCY ANALYSES,
Universidade Federal do Parana, Curitiba (Brazil).
For primary bibliographic entry see Field 2E.
W89-05677

ANALYSIS OF FLOOD FREQUENCIES IN THE CAUVERY VALLEY,
National Inst. of Engineering, Mysore (India).
For primary bibliographic entry see Field 2E.
W89-05678

MULTIVARIATE STOCHASTIC FLOOD ANALYSIS USING ENTROPY,
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
P. F. Krstanovic, and V. P. Singh.
IN: Hydrologic Frequency Modeling: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 515-539, 8 fig, 2 tab, 26 ref.

Descriptors: *Stochastic hydrology, *Statistical analysis, *Flood forecasting, Mathematical studies, Entropy, Flood frequency, Design floods, Flood data, Flood hydrographs.

The principle of maximum entropy was used to derive a multivariate stochastic model for flood analysis. By specifying appropriate constraints in terms of covariances, variances and cross-covariances, multivariate Gaussian and exponential distributions were derived. As a special case, the bivariate process of flood peaks and volumes was investigated for three cases: the peaks and volumes are independent and occur the same number of times; the number of peaks is more than that of volumes in the same time interval; and peaks and volumes exhibit dependence. Special emphasis was given to the structure of the matrix of Lagrange multipliers in the model. Marginal distributions of flood characteristics were obtained, first with no restrictions imposed, and then with assumptions of independent occurrences and a high threshold value. The conditional distribution of flood volume given the peak was discussed. This multivariate stochastic model was related to maximum entropy spectral analysis. This relationship was shown by deriving power spectrum from marginal distributions of flood characteristics and cross-spectrum from the bivariate distribution of peaks and volumes. This connection has two useful practical applications: use of the derived distributions in statistical inference and use of the spectral analysis for prediction and reconstruction of historical records. (See also W89-05642) (Author's abstract)
W89-05679

MULTIVARIATE PARTIAL DURATION SERIES IN FLOOD RISK ANALYSIS,
Director-General for Natural Resources, Lisbon (Portugal).
For primary bibliographic entry see Field 2E.
W89-05680

ANOTHER LOOK AT THE JOINT PROBABILITY OF RAINFALL AND RUNOFF,
Oklahoma State Univ., Stillwater. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 2A.
W89-05681

BIVARIATE FLOOD MODEL AND ITS APPLICATION,
Technische Univ., Graz (Austria). Inst. for Hydromechanics, Hydraulics and Hydrology.
For primary bibliographic entry see Field 2E.
W89-05682

ANALYSIS AND SIMULATION OF THREE-COMPONENT FLOODS IN THE OHIO RIVER BASIN,
Ohio Univ., Athens. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W89-05683

PROBABILISTIC MODEL FOR FLOODING DOWNSTREAM OF THE JUNCTION OF TWO RIVERS,
Universidad Nacional Autonoma de Mexico, Mexico City. Facultad de Ingenieria.
For primary bibliographic entry see Field 2E.
W89-05684

CONCURRENT FLOODING PROBABILITIES,
Missouri Univ.-Rolla. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W89-05685

BIVARIATE ANALYSIS OF CONCURRENT FLOODING,
Missouri Univ.-Rolla. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W89-05686

NORTH LYNN DRAINAGE SCHEME: HYDRAULIC MODEL STUDIES,
British Hydromechanics Research Association, Cranfield (England).
For primary bibliographic entry see Field 8B.
W89-05749

MODELING GROUNDWATER FLOW AND POLLUTION: WITH COMPUTER PROGRAMS FOR SAMPLE CASES,
Technion - Israel Inst. of Tech., Haifa. Faculty of Civil Engineering.
For primary bibliographic entry see Field 2F.
W89-05754

COMPUTATIONAL METHODS IN SUBSURFACE FLOW,
GeoTrans, Inc., Reston, VA.
For primary bibliographic entry see Field 2F.
W89-05755

RECHARGE STUDIES IN THE WESTERN MURRAY BASIN: 1. RESULTS OF A DRILLING PROGRAM AT BORRIKA,
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Soils.
For primary bibliographic entry see Field 2F.
W89-05757

WATER EROSION IN THE DRYLAND CROPPING REGIONS OF AUSTRALIA: 5. LAND AND LAND USE DATA FOR A RELATIVE ASSESSMENT OF POTENTIAL SOIL MOVEMENT IN WESTERN AUSTRALIA,
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
For primary bibliographic entry see Field 2J.
W89-05758

ANNUAL REPORT, ANALYSIS OF ACID PRECIPITATION SAMPLES COLLECTED BY STATE AGENCIES,
Global Geochemistry Corp., Canoga Park, CA.
For primary bibliographic entry see Field 5B.
W89-05759

MONTHLY STREAMFLOW AND GROUNDWATER CONDITIONS IN THE UNITED STATES AND SOUTHERN CANADA, WATER YEARS 1945-85,
Geological Survey, Reston, VA. Water Resources Div.
S.L. Holmes.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Supply Paper 2314, 1987. 250p, 496 fig, 3 ref.

Descriptors: *Streamflow, *Groundwater, *Water supply, *Hydrologic data, *Water resources data, *Data collections, Surface water, Drought, Floods, Water Resources Review, National Water Conditions.

The Water Resources Division of the U.S. Geological Survey has been measuring streamflow since 1888 and collecting groundwater data since 1894. The monthly publication, Water Resources Review (now National Water Conditions), was established in water years 1945 for the purposes of quickly providing information to the public on the status of surface- and ground-water resources of the Nation. Each monthly issue contains a map depicting the status of water conditions relative to normal for that month. This report presents these maps, along with a synopsis of surface- and ground-water conditions, for the last 41 years (1945-85). A water year begins October 1 and ends September 30 of the following year. (USGS)
W89-05771

OPERATIONAL, SPATIAL, AND ENVIRONMENTAL WATER PLANNING AND ANALYSIS-PHASE II,
Michigan State Univ., East Lansing. Dept. of Resource Development.
For primary bibliographic entry see Field 5G.
W89-05772

ASSESSMENT OF RURAL GROUNDWATER CONTAMINATION BY AGRICULTURAL CHEMICALS IN SENSITIVE AREAS OF MICHIGAN,
Michigan State Univ., East Lansing. Inst. of Water Research.
J. L. Ervin, and K. M. Kittleson.
Available from National Technical Information Service, Springfield, VA 22161 as PB89-102206/AS, price codes: A03 in paper copy, A01 in microfiche. Technical Report No. G1429-03, April 1988. 35 p, 13 fig, 7 tab, 20 ref, append. Contract 14-08-0001-G1429. Project USGS G1429-03.

Descriptors: *Groundwater pollution, *Agricultural chemicals, *Nitrates, *Atrazine, *Michigan, Groundwater, Aquifer vulnerability, Water wells, Water supply, Drinking water, Groundwater quality, Water pollution sources, Pollutant identification, Water analysis, Rural areas, Herbicides.

The vulnerability of drinking water supplies to agricultural contamination in three Michigan counties is discussed. The results of nitrate and atrazine analysis of drinking water from 38 wells in those 3 countries is described. Widespread nitrate contamination was demonastrated in agricultural areas with vulnerable aquifers. In addition, atrazine, a widely used herbicide was found in 11 of the 38 well samples, with concentrations and patterns not conforming to findings in other mid-western states. The need for a comprehensive inventory of the groundwater quality in rural areas of Michigan is emphasized in this report, which describes results from the first year of a 2 year study. (USGS)
W89-05784

8. ENGINEERING WORKS

8A. Structures

CASE STUDIES OF DEEP WELL HAZARDOUS WASTE DISPOSAL - GULF COAST, GREAT LAKES AND CALIFORNIA,
Engineering Enterprises, Inc., Norman, OK.
For primary bibliographic entry see Field 5E.
W89-04584

LOW SLUMP COMPACTION GROUTING FOR CORRECTION OF CENTRAL FLORIDA SINKHOLES,
GKN Hayward Baker, Inc., Tampa, FL.
For primary bibliographic entry see Field 4B.
W89-04604

ROCK RIPRAP DESIGN FOR PROTECTION OF STREAM CHANNELS NEAR HIGHWAY STRUCTURES VOLUME 1--HYDRAULIC CHARACTERISTICS OF OPEN CHANNELS,
Geological Survey, Sacramento, CA. Water Resources Div.

J. C. Blodgett.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4127, 1986. 60p, 14 fig, 18 tab.

Descriptors: *Hydraulic properties, *Open channels, *Bank protection, *Riprap, *Highways, Streamflow, Hydraulic design, Hydraulic geometry, Channel morphology.

Volume I discusses the hydraulic and channel properties of streams, based on data from several hundred sites. Streamflow and geomorphic data have been collected and developed to indicate the range in hydraulic factors typical of open channels, to assist design, maintenance, and construction engineers in preparing rock riprap bank protection. Typical channels were found to have maximum-to-mean depth ratio of 1.55 and a ratio of hydraulic radius to mean depth of 0.98, which is independent of width. Most stable channel characteristics for a given discharge are slope, maximum depth, and hydraulic radius. (See also W89-04911) (Author's abstract)
W89-04910

ROCK RIPRAP DESIGN FOR PROTECTION OF STREAM CHANNELS NEAR HIGHWAY STRUCTURES VOLUME 2--EVALUATION OF RIPRAP DESIGN PROCEDURES,
Geological Survey, Sacramento, CA. Water Resources Div.
J. C. Blodgett, and C. E. McConaughy.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4128, 1986. 95p, 38 fig, 12 tab, 51 ref.

Descriptors: *Bank protection, *Riprap, *Design criteria, *Channels, *Highways, Engineering design, Mechanical failure, Slopes, Bank erosion, Flow velocity, Channel morphology.

In volume 2, seven procedures now being used for design of rock riprap installations were evaluated using data from 26 field sites. Four basic types of riprap failures were identified: Particle erosion, translational slide, modified slump, and slump. Factors associated with riprap failure include stone size, bank side slope, size gradation, thickness, insufficient toe or endwall, failure of the bank material, overtopping during floods, and geomorphic changes in the channel. A review of field data and the design procedures suggests that estimates of hydraulic forces acting on the boundary based on flow velocity rather than shear stress are more reliable. Several adjustments for local conditions, such as channel curvature, superelevation, or boundary roughness, may be unwarranted in view of the difficulty in estimating critical hydraulic forces for which the riprap is to be designed. Success of the riprap is related not only to the appropriate procedure for selecting stone size, but also to the reliability of estimated hydraulic and channel factors applicable to the site. (See also W89-04910) (Author's abstract)
W89-04911

EFFECT OF NIAGARA POWER PROJECT ON GROUND WATER FLOW IN THE UPPER PART OF THE LOCKPORT DOLOMITE, NIAGARA FALLS AREA, NEW YORK,
Geological Survey, Ithaca, NY. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-04913

STATISTICAL ANALYSIS RELATING WELL YIELD TO CONSTRUCTION PRACTICES AND SITING OF WELLS IN THE PIEDMONT AND BLUE RIDGE PROVINCES OF NORTH CAROLINA,
Geological Survey, Raleigh, NC. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-04914

DISCHARGE RATINGS FOR CONTROL GATES AT MISSISSIPPI RIVER LOCK AND DAM 12, BELLEVUE, IOWA,
Geological Survey, Iowa City, IA. Water Resources Div.
A. J. Heinitz.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4135, 1986. 43p, 15 fig, 6 tab, 15 ref.

Descriptors: *Locks, *Dams, *Gates, *Flow discharge, *Mississippi River, *Stream gaging, *Iowa, *Discharge measurement, Orifice flow, Forebays, Tailwater.

The water level of the navigation pools on the Mississippi River are maintained by the operation of tainter and roller gates at the locks and dams. Discharge ratings for the gates on Lock and Dam 12, at Bellevue, Iowa, were developed from current-meter discharge measurements made in the forebays of the gate structures. Methodology is given to accurately compute the gate openings of the tainter gates. Discharge coefficients, in equations that express discharge as a function of tailwater head, forebay head, and height of gate opening, were determined for conditions of submerged-orifice and fee-weir flow. A comparison of the rating discharges to the hydraulic-model rating discharges is given for submerged orifice flow for the tainter and roller gates. (Author's abstract)
W89-04917

DISCHARGE RATINGS FOR CONTROL GATES AT MISSISSIPPI RIVER LOCK AND DAM 16, MUSCATINE, IOWA,
Geological Survey, Iowa City, IA. Water Resources Div.
A. J. Heinitz.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4136, 1986. 36p, 11 fig, 6 tab, 14 ref.

Descriptors: *Locks, *Dams, *Gates, *Flow discharge, *Mississippi River, *Stream gaging, *Discharge measurement, *Iowa, Orifice flow, Forebays, Tailwater.

The water level of the navigation pools on the Mississippi River are maintained by the operation of tainter and roller gates at the lock and dams. Discharge ratings for the gates on Lock and Dam 16, at Muscatine, Iowa, were developed from current-meter discharge measurements made in the forebays of the gate structures. Methodology is given to accurately compute the gate openings of the tainter gates. Discharge coefficients, in equations that express discharge as a function of tailwater depth, headwater depth, and vertical height of gate opening, were determined for conditions of submerged-orifice flow. A comparison of the rating discharges to the hydraulic-model rating discharges is given for submerged-orifice flow for the tainter and roller gates. (Author's abstract)
W89-04918

DISCHARGE RATINGS FOR CONTROL GATES AT MISSISSIPPI RIVER LOCK AND DAM 22, SAVERTON, MISSOURI,
Geological Survey, Iowa City, IA. Water Resources Div.
A. J. Heinitz.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4137, 1986. 37p, 11 fig, 6 tab, 17 ref.

Descriptors: *Stream gaging, *Locks, *Dams, *Gates, *Flow discharge, *Mississippi River, *Missouri, *Discharge measurement, Orifice flow, Forebays, Tailwater.

The water level of the navigation pools on the Mississippi River are maintained by the operation of tainted and roller gates at the locks and dams. Discharge ratings for the gates on Lock and Dam 22, at Saverton, Missouri, were developed from current-meter discharge measurements made in the forebays of the gate structures. Methodology is given to accurately compute the gate openings of the tainter gates. Discharge coefficients, in equations that express discharge as a function of tailwater head, forebay head, and height of gate opening, were determined for conditions of submerged-orifice and free-weir flow. Rating discharges are given for comparison to those used in the operation schedule, Plan A, which is in use for the operation of Lock and Dam 22. (Author's abstract)
W89-04919

DEPOSITION OF SOLIDS IN DRILLING FLUIDS ON BOREHOLE WALLS,
Washington State Univ., Pullman. Dept. of Civil Engineering.
For primary bibliographic entry see Field 7B.
W89-05058

USE OF CHANGE CONSTRAINTS IN RESERVOIR DESIGN AND OPERATION MODELING,
Wright State Univ., Dayton, OH. Dept. of Geology.
For primary bibliographic entry see Field 4A.
W89-05067

ANALYSES OF DAM FAILURES IN 1985 CHILEAN EARTHQUAKE,
New Hampshire Univ., Durham. Dept. of Civil Engineering.
P. A. De Alba, H. B. Seed, E. Retamal, and R. B. Seed.
Journal of Geotechnical Engineering (ASCE) JGENDZ, Vol. 114, No. 12, p 1414-1434, December 1988. 13 fig, 1 tab, 7 ref. NSF Grant ECE-8411912.

Descriptors: *Dam failure, *Dams, *Earthquakes, *Chile, *Embankments, *Deformation, Foundation failure, Earthworks, Rheology, Soil strength, Stress, Strength, Soil types, Reservoirs, Silt, Sediments.

During the Central Chile earthquake of 1985, two small dams suffered substantial embankment deformations indicating liquefaction and major strength loss in the embankment of foundation soils. However, the configuration of the embankments after failure suggested that the soil had retained a small but significant residual strength after initial liquefaction. Because of the scarcity of field values of residual strength after initial liquefaction, a study of these dams was undertaken. Standard penetration test (SPT) values were determined and normalized for effective confining stress and hammer energy. Silty sand layers of low density were identified near the base of both embankments. Subsequent analysis of the results of the field study gave upper and lower bounds of residual strength in these loose layers. Calculated values of residual strength were found to vary with the inferred preearthquake densities of the materials. These values were compared with those determined from previous case studies and shown to be in reasonable agreement. (Author's abstract)
W89-05344

EMERGENCY REHABILITATION OF OUAGADOUGOU DAM NO. 2, BURKINA FASO,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
P. Roark, R. H. Wood, and V. J. Layton.
Water and Sanitation for Health Project Field Report No. 192, October 1986. 114p, 3 fig, 2 append. AID Contract 5942-C-00-4085-00, Project 936-5942.

Descriptors: *Ouagadougou Dam, *Maintenance, *Burkina Faso, Dam failure, Hydraulic structures, Dams, Costs, Spillways, Leakage, Embankments.

At the request of the USAID Mission in Burkina Faso, a WASH team visited Burkina Faso between March 2 and March 25, 1985. The WASH team recommended several immediate and long-term solutions to the water supply shortage. Several recommendations focused on improving the efficiency of use of the water supplied by the series of three

reservoirs located on the edge of Ouagadougou. Dam Number 2 was partially collapsed and in a generally deteriorated state. Further evaluation indicated that the subsidence of the dam spillway was due to leakage through the spillway foundation material. Repairs proposed by the Government of Burkina Faso for the dam were found to be appropriate with some modifications. The primary suggested modifications were a reduction in the amount of embankment replacement, the addition of seepage cutoff walls under the proposed spillway, and the addition of filter fabric to reduce the loss of fines from the embankment. The initial cost estimate for the repairs totaled $1 million. The rehabilitation of Dam Number 2 was successfully completed on time and within budget (except for currency fluctuations which were obviously outside the project's domain of influence). (Lantz-PTT)
W89-05386

TELEGRAPH CANYON CREEK CHANNEL IMPROVEMENT PROJECT, SAN DIEGO COUNTY, CALIFORNIA: HYDRAULIC MODEL INVESTIGATION,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
G. A. Pickering, and J. F. George.
Available from the National Technical Information Service, Springfield, VA 22161. Technical Report HL-88-26, November 1988. Final Report. 60p, 10 fig, 6 photos, 26 plates.

Descriptors: *Hydraulic structures, *Telegraph Canyon Creek, *Channels, *Hydraulic models, California, San Diego, Model studies, Flow profiles, Culverts, Tailwater, Hydraulic design, Riprap.

Tests were conducted on a 1:20-scale model of Telegraph Canyon to determine the amount of head that would be required to increase the capacity of the culverts from 1,700 cfs to 3,300 cfs, and to develop an energy dissipator design downstream from the existing culverts. Initially, the model reproduced approximately 3,400 ft of the channel and culverts from station 69+39 to 35+31. Later in the testing program, the model was modified to reproduce upstream channel improvements to station 78+00 to reflect the change in location of the inlets to the box culvert from stations 59+70 to 67+40. The trajectory curve between the outlet and stilling basin as originally designed was 78 ft long. A much shorter (30 ft) and steeper trajectory curve was found to perform just as satisfactorily as the longer and more expensive curve. The original stilling basin was 60 ft wide and 45 ft long with the apron at elevation (el) -0.08 (elevations are in feet referred to the National Geodetic Vertical Datum). Unsatisfactory flow conditions were observed in this basin with the design discharge and minimum tailwater. A satisfactory design was developed with the 60-ft width by lowering the apron elevation 1 ft and rearranging the basin elements. However, a much more economical design was developed by narrowing the basin width to 40 ft and shortening the apron length to 36 ft. A 24-in.-thick layer of 12-in riprap was stable for all discharge and tailwater combinations tested with the recommended stilling basin. The 12-in. riprap was considered the smallest practical size that should be used in the prototype, and smaller sizes were not tested. (Lantz-PTT)
W89-05399

NEW APPROACHES AND APPLICATIONS IN SUBSURFACE FLOW MODELING: 3-D FINITE ELEMENT ANALYSIS OF DEWATERING FOR AN ELECTRO-NUCLEAR PLANT,
Padua Univ. (Italy). Inst. of Applied Mathematics.
G. Gambolati, A. Monaco, G. Galeati, F. Uliana, and P. Mosca.
IN: Groundwater Flow and Quality Modelling. D. Reidel Publishing Co., Boston. 1988. p 717-759, 30 fig, 3 tab, 16 ref.

Descriptors: *Drainage, *Model studies, *Mathematical models, *Groundwater movement, *Nuclear powerplants, *Finite element method, Hydraulic structures, Geohydrology, Rice, Cutoffs, Recharge.

The construction of the foundation of the 2,000 MW electro-nuclear plant to be built at Trino Vercellese, 70 km west of Milan, Italy, requires the dewatering of a large area located amidst a productive agricultural land primarily dedicated to the culture of rice. To reduce the impact on the environment and particularly on the existing hydrologic regime, a number of remedial measures are planned including the construction of a concrete cut-off wall entirely encompassing the dewatered site and the excavation of recharging ditches to reinject the water withdrawn. To assist in the design of the dewatering system and the emergency wells to cope with a possible accident in the cooling water circuit, a 3-D finite element model of subsurface flow is developed and applied using the data derived from the 'ad hoc' reconnaissance study, soil borings and pumping tests. The model fully takes into consideration the artificial elements (wall and ditches) of the simulated system and provides the necessary information as to the overall quantity of water to be pumped out to dewater the site and the amount which can be safely reinjected. It explores the effectiveness of the low permeability barrier and recharging trenches to contain the propagation of the water table decline beyond the area directly involved in the project. The model also allows for the correct design of the wells whose emergency use is planned during a hypothetical accident in the cooling scheme of the nuclear reactors. (See also W89-05465) (Author's abstract)
W89-05502

PALEOFLOOD HYDROLOGY AND DESIGN APPLICATIONS,
Arizona Univ., Tucson. Dept. of Geosciences.
For primary bibliographic entry see Field 2E.
W89-05639

RAINFALL FREQUENCY STUDIES FOR CENTRAL SAUDI ARABIA,
King Saud Univ., Riyadh (Saudi Arabia). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2B.
W89-05664

ADVANCED DAM ENGINEERING FOR DESIGN, CONSTRUCTION, AND REHABILITATION.
Van Nostrand Reinhold, New York, NY. 1988. 811p. Edited by Robert B. Jansen.

Descriptors: *Dam rehabilitation, *Dam construction, *Dam design, *Dam failure, *Geology, *Construction materials, *Concrete dams, *Outlets, Hydrology, Seismology, Cofferdams, Earthquake engineering, Embankments, Earth dams, Rockfill dams, Gravity dams, Arch dams, Dam foundations, Dam stability, Spillways, Reservoirs.

Advances in dam engineering that have been achieved in recent years or are under way are presented. Attention is given to practical aspects of design, construction, operation and rehabilitation. Case histories are reviewed to demonstrate principles and procedures of proven value, including lessons drawn from, or reinforced by, accidents and failures are examined. The fundamentals of this field are covered primarily as a means of introducing and facilitating an understanding of concepts and practices that represent the leading edge of technology. Both simplified and comprehensive procedures are presented. Strong emphasis is placed on technical aspects, with only general consideration given to administrative, financial, social, legal, environmental, and political factors, which, though important, are covered in other publications. (See W89-05688 thru W89-05745) (Shidler-PTT)
W89-05687

LESSONS FROM NOTABLE EVENTS: THE BALDWIN HILLS RESERVOIR FAILURE,
Leps (Thomas M.), Inc., Menlo Park, CA.
For primary bibliographic entry see Field 8E.
W89-05688

LESSONS FROM NOTABLE EVENTS: THE FAILURE OF MALPASSET DAM,
L. B. James.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 17-27,58-59, 13 fig, 15 ref.

Descriptors: *France, *Malpasset Dam, *Dam failure, *Arch dams, *Dam foundations, *Engineering geology, Dam design, Dam stability, Stress, Construction methods, Feasibility studies, Core drilling, Permeability, Geophysics, Compressive strength.

Malpasset, Dam, France failed suddenly in December 1959 although a few hours earlier engineers had detected nothing unusual at the site. The dam was located in a narrow gorge of the Reyran River approximately 12 km upstream of Frejus, a resort community on the French Riveria. It was a double-curvature arch of 66.5 m maximum height, with crest length of 222 m and thickness that varied from 1.5 to 6.77 m. Internal foundation stresses were an essential element in the failure. Preconstruction geological investigation included inspection of the site by a professor of geology, eight grout holes 20 to 30 m in depth, and examination of the foundation excavation. It is not clear whether the geologist was duly informed when the design was changed from a gravity to an arch dam. In retrospect, the Malpasset experience has demonstrated some critical practices for the construction of safe arch dams. The feasibility study for an arch dam must include detailed investigations guided by a geologist who is familiar with both arch dam design and the local and regional geological context, accompanied by in-situ and laboratory tests, e.g., core drilling, permeability, jacking tests in adits, geophysical surveys, effect of water on compression test results, etc. When values comparable to those determined for the Malpasset site are reached, consideration should be given to discarding an arch design. (See also W89-05687) (Shidler-PTT)
W89-05689

LESSONS FROM NOTABLE EVENTS: THE ST. FRANCIS DAM FAILURE,
For primary bibliographic entry see Field 8E.
W89-05690

LESSONS FROM NOTABLE EVENTS: FAILURE OF TETON DAM,
Leps (Thomas M.), Inc., Menlo Park, CA.
For primary bibliographic entry see Field 8E.
W89-05691

LESSONS FROM NOTABLE EVENTS: VAIONT RESERVOIR DISASTER,
Kiersch Associates, Inc., Tucson, AZ.
For primary bibliographic entry see Field 8E.
W89-05692

LESSONS FROM NOTABLE EVENTS: THE WALTER BOULDIN DAM FAILURE,
Leps (Thomas M.), Inc., Menlo Park, CA.
T. M. Leps.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 53-58, 4 fig.

Descriptors: *Walter Bouldin Dam, *Alabama, *Dam failure, *Dam foundations, *Hydroelectric plants, *Pipe flow, *Dam design, Erosion, Forebays, Dikes, Tailrace, Excavation.

The Walter Bouldin Project consists of a forebay fed by gravity via a canal from nearby Jordan Reservoir (on the Coosa River, Alabama), a 225 MW powerplant and gated intake on the perimeter at the deepest point of the forebay, two forebay dikes extending right and left from the intake/powerhouse complex, and a 5-mile-long excavated tailrace channel. The 1975 failure of the dam caused no injuries, and little damage except to project facilities. At the failed section, all alluvium and Cretaceous strata had been excavated for the

intake and powerhouse foundations down to massive mica schist, and the adjacent dike embankment therefore was founded on the slope resulting from the deep excavation, thus resting on both schist and Cretaceous formations. Because there was no drawdown event in the forebay to trigger an upstream slope failure, and there was no physical distress evident at the dike crest as late as 8 hours before the first notice of failure, it is most probable that the dike failed initially by foundation piping in the highly-erodible Cretaceous Formation, followed by collapse of the crest into the quickly enlarging 'pipe'. The redesign and reconstruction of the damaged reaches of the dikes were deliberately conservative, utilizing the best modern practices. Reconstruction was completed in 1981, and the project has been in satisfactory operation since that time. (See also W89-05687) (Shidler-PTT)
W89-05693

HYDROLOGY,
Pacific Gas and Electric Co., San Francisco, CA.
C. B. Cecilio, A. D. Feldman, and L. L. Cross.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 60-105, 22 fig, 5 tab, 86 ref.

Descriptors: *Dam design, *Reservoir design, *Design floods, *Hydrologic aspects, *Safety, Spillways, Waves, Wave runup, Flood-control storage, Hydrograph analysis, Runoff volume, Reservoir releases, Reviews.

The determination of hypothetical floods for use in the design and safety evaluation of dams, reservoirs, spillways, and diversion structures is reviewed. Wind-generated waves for determining freeboard allowances are also addressed. Flood studies are performed to determine the reservoir storage necessary to accommodate a given flood, the dimensions of the spillway needed to pass excess floodwaters, the freeboard allowance required during the occurrence of an inflow design flood, or an appropriate safety evaluation flood for an existing dam. The design and evaluation of dams against hypothetical floods requires determination of the hydrologic response (infiltration, base flow, routing, and runoff) of watersheds to intense rainfall or snowmelt, with verification based on historical storm and runoff data (flood hydrograph analysis). The frequency of occurrence of both peak streamflows and runoff volumes is the basis for reservoir spillway, outlet, and storage capacity design. It is current practice to estimate freeboard allowances for wave action above the maximum reservoir surcharge level to be equal to the computed height of runup of the significant wave as computed from adopted wind criteria. Reservoir rule curves and allowable release rates are developed from a study of the streamflow record for the periods most critical with respect to the desired operation. (See also W89-05687) (Shidler-PTT)
W89-05694

GEOLOGY: GEOLOGICAL CONSIDERATIONS; REGIONAL-AREAL GEOSCIENCE INVESTIGATIONS,
Kiersch Associates, Inc., Tucson, AZ.
For primary bibliographic entry see Field 8E.
W89-05695

GEOLOGY: FOUNDATION DEFECTS,
Bechtel Civil and Minerals, Inc., San Francisco, CA.
For primary bibliographic entry see Field 8E.
W89-05698

SEISMOLOGY,
California Univ., Berkeley. Seismographic Station.
For primary bibliographic entry see Field 8E.
W89-05699

MATERIALS: DISPERSIVE CLAYS,
Bureau of Reclamation, Denver, CO. Geotechnical Branch.
For primary bibliographic entry see Field 8D.
W89-05701

MATERIALS: GEOSYNTHETICS IN DAM CONSTRUCTION,
Bureau of Reclamation, Denver, CO. Applied Sciences Branch.
For primary bibliographic entry see Field 8G.
W89-05702

MATERIALS: CONVENTIONAL CONCRETE FOR DAMS,
For primary bibliographic entry see Field 8F.
W89-05703

MATERIALS: SPECIAL CONCRETES,
For primary bibliographic entry see Field 8F.
W89-05704

MATERIALS: MATERIALS AND MIXTURE PROPORTIONING CONCEPTS FOR ROLLER COMPACTED CONCRETE DAMS,
Bureau of Reclamation, Denver, CO.
For primary bibliographic entry see Field 8F.
W89-05705

COFFERDAMS,
E. P. Swatek, and C. A. Fetzer.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 219-238, 18 fig, 25 ref.

Descriptors: *Cofferdams, *Dam construction, *Earth dams, *Rockfill dams, *Piles, Sheet-steel piles, Cellular cofferdams, Economic aspects, Dam design, Floods, Engineering geology, History, Hydrologic aspects, Dam failure, Diversion dams, Construction methods.

Steel-sheetpile cellular cofferdams and earth and rockfill cofferdams are described. The economic comparison between a cellular sheetpile and an embankment cofferdam is complex. For the cellular sheetpile type the quantity of fill is less than one-half per unit of length for cofferdams of equal height. Freestanding cofferdams consisting of a single row of circular cells now can be designed for a height of 95 ft (29 m). The design height of cellular cofferdams can be lower because they are easily protected from overtopping floods. The important geological features are depth to bedrock or impervious stratum, and the overburden profile. History and development, hydrologic considerations, cell types, design, layout, construction, dewatering, and failures of cellular cofferdams are also discussed. With all the theorizing that has been done in the last 50 years concerning cellular sheetpile structures, design is still empirical, with a good flavoring of experience and judgement. Earth and rockfill cofferdams are still the most commonly-used structures for diversion and for protection of the work area during construction of the main dam. To reduce the chances of failure, many designers now are providing higher cofferdams, and devising methods for constructing them to full height in short periods of time. The trend to higher cofferdams will continue. (See also W89-05687) (Shidler-PTT)
W89-05707

EARTHFILL DAM DESIGN AND ANALYSIS,
R. B. Jansen, J. Lowe, R. W. Kramer, and S. J. Poulos.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 256-320, 48 fig, 4 tab, 72 ref.

Descriptors: *Earth dams, *Dam design, *Dam stability, *Stability analysis, *Materials engineering, Topography, Engineering geology, Slope protection, Dam foundations, Seepage control, Drawdown, Seismic properties, Liquefaction.

The design and analysis of an earthfill are governed largely by the engineering properties of the available materials; the topography and geology of the site; the climatic, hydrologic, and seismic settings; and the relationships to other developments upstream and downstream. Design features include alignment, freeboard, crest details, zoning of the fill materials, slope protection, foundation preparation, abutment details, and foundation seepage control. Seepage analysis is prerequisite to filter design, a critical item in the design of earthfill dams. Stability analyses generally are made by limit-equilibrium methods; the slices and sliding-block methods are the two most-common techniques for carrying out limit-equilibrium analyses. Other methods and considerations in stability analysis for earthfill dams are infinite-slope analysis, steady-seepage and partial-pool cases, the rapid-drawdown case, and earthquake loading. Special consideration is given to differential settlement and cracking, hydraulic fracturing, and simplified estimating of deformation under seismic loading. The seismic design of the Sugar Pine Dam (California) and seepage-control measures in the design and construction of the Calamus Dam (Nebraska) are presented as case histories. The principles and practice of liquefaction and related phenomena are also analyzed. (See also W89-05687) (Shidler-PTT)
W89-05709

EARTHFILL DAM PERFORMANCE AND REMEDIAL MEASURES,
For primary bibliographic entry see Field 8D.
W89-05711

ROCKFILL DAM PERFORMANCE AND REMEDIAL MEASURES,
Leps (Thomas M.), Inc., Menlo Park, CA.
T. M. Leps.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 409-415, 2 tab, 21 ref.

Descriptors: *Rockfill dams, *Dam stability, *Deformation, *Leakage, *Maintenance, Dam construction, Dam design, Compaction, Earthquakes, Damage, Construction joints, Cracks, Grouting.

All rockfill dams experience measurable deformations during and after construction. The objective of modern design is to minimize those deformations enough that they cannot adversely affect the integrity and performance of core zones or face membranes. It has been demonstrated convincingly that the usual way to achieve this is to require such densification of the rockfill during construction that it can deform very little thereafter, either under gravity and reservoir loading or under severe seismic shaking. All dams leak; the primary challenge is to control leakage so that it can not foreseeably impair the safety of the dam. The essential first step in effecting adequate repair, where deformation and leakage-caused damages have occurred, is to arrive at a credible diagnosis of the problem and the degree of urgency for remedial action. For older, dumped-rockfill concrete-face rockfill dams, remedial measures have most frequently consisted of repairing spalled, offset, and badly-leaking face-slab joints, where separation and displacement of joints have been as much as 9 in. (23 cm). Where initial piping through thin earth cores has been detected by suddenly-increased and turbid leakage, leakage control has been improved by low-pressure grouting of the core through holes drilled from the crest. The repairs of cracks in the crest generally have been simple and straightforward. (See also W89-05687) (Shidler-PTT)
W89-05714

GRAVITY DAM DESIGN AND ANALYSIS,
C. F. Corns, E. K. Schrader, and G. S. Tarbox.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 466-492, 19 fig, 22 ref.

Descriptors: *Gravity dams, *Buttress dams, *Concrete dams, *Dam design, *Stability analysis, Weight, Dam foundations, Seepage control, Spillways, Water pressure, Earthquakes, Safety.

A gravity dam is an essentially-solid concrete structure that resists imposed forces principally by

its own weight. A buttress dam is a gravity structure that, in addition to its own weight, utilizes the weight of water over the upstream face to provide stability. Current concepts and practices in regard to loading conditions and methodologies of analysis are presented, together with descriptions of the principal design features of gravity and buttress dams. Design features include dam sections, foundations, seepage control, monolith joints, construction joints, galleries, spillway bridge, spillway piers, and reinforcement. Loads commonly considered in the design and analysis of a gravity or buttress dam are dead load, external water pressure, internal water pressure (uplift), earth and silt pressure, earthquake forces, ice pressure, wind pressure, temperature, subatmospheric pressure, and foundation reaction. The following loading conditions normally are investigated: construction condition, construction condition with earthquake, normal operating condition, flood condition, and normal operating condition with earthquake. Under all conditions of loading, a gravity or buttress dam should be safe against overturning, safe against sliding, and safe against overstressing in the dam or in the foundation. (See also W89-05687) (Shidler-PTT)
W89-05716

ARCH DAM DESIGN AND ANALYSIS,
H. L. Boggs, R. B. Jansen, and G. S. Tarbox.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 493-539, 34 fig, 10 tab, 65 ref.

Descriptors: *Arch dams, *Dam design, *Stability analysis, *Design criteria, Finite element method, Risk assessment, Concrete technology, Rehabilitation, Case studies, Multiple arch dams, Roller-compacted concrete.

A historical perspective is presented of the last decade, in reference to: revised and new arch-dam design criteria (including extreme flood hazards, dam-break analysis, and earthquake hazard), evolution of arch shapes and optimum shape-design methods, linear dynamic analysis, static and dynamic nonlinear analysis, preprocessing and post-processing of finite-element analysis data, suitability of roller-compacted concrete technology for arch dams, evaluation of existing arch dams, and risk assessment applied to arch dams. The most significant development in concrete-dam design and construction in the decade from 1975 to 1985 was the use of roller-compacted concrete technology in construction; to date, however, RCC technology has not been used to construct an arch dam. Rehabilitation steps include records review, on-site examination, evaluation, recommendations, and repair/rehabilitation. A case history is presented of the Klang Gates Dam (Malaysia) enlargement including history, alternative designs, bonding of concrete at the downstream face, and spillway revisions. Another case history, is that of the Stewart Mountain Dam (Arizona), which experienced a concrete-expanding alkali/aggregate reaction. The Florence Lake Dam, built in California in 1926, is presented as an example of multiple-arch dams. (See also W89-05687) (Shidler-PTT)
W89-05717

CONCRETE DAM CONSTRUCTION AND FOUNDATION TREATMENT,
E. K. Schrader, and W. F. Swiger.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 540-577, 9 fig, 24 ref.

Descriptors: *Concrete dams, *Dam construction, *Construction methods, *Dam foundations, *Concrete technology, Project planning, Personnel, Scheduling, Construction materials, Temperature control, Foundation rocks, Seepage, Compaction, Roller-compacted concrete.

Organization (staffing and the interaction of the owner/designer and his inspection forces with the contractor's staff) and schedule and scheduling techniques are reviewed, but actual construction operations are considered in more detail, emphasizing advances made within the past ten years. Regardless of the owner/designer/contractor arrangement, the interaction and relationship among them are crucial to the success of the project, in terms of quality, schedule, and profitability. Phased construction, diversion schemes, planning to avoid interruptions during construction, and scheduling of labor are all aspects of effective scheduling. Execution or actual construction operations involve project documentation, site preparation, foundation treatment, sources and use of aggregates, concrete production, batching and mixing, concrete plant control, delivery, placing and consolidation, and cooling and temperature control. Except for barrage-type dams in alluvial river valleys, concrete dams usually are founded on rock. Reservoir pressures and seepage impose severe performance requirements on the foundations of a concrete dam, especially a high concrete dam. The development of roller-compacted concrete has been a major recent advance in efficient dam design and construction. The method is applicable to new dams and cofferdams and to rehabilitation of old structures. (See also W89-05687) (Shidler-PTT)
W89-05718

CONCRETE DAM PERFORMANCE AND REMEDIAL MEASURES,
R. B. Jansen, G. Lombardi, and C. F. Corns.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 578-608, 24 fig, 27 ref.

Descriptors: *Concrete dams, *Concrete technology, *Dam stability, *Mechanical failure, *Maintenance, Seepage, Deterioration, Gravity dams, Uplift pressure, Cracks, Dam foundations, Arch dams, Buttress dams, Design criteria, Shear stress, Grouting, Damage, Drainage, Case studies.

The stability of a concrete dam may be jeopardized by various forces and conditions. Common problems include alkali/aggregate reaction, freezing and thawing, leaching, and sulfate attack. The stability of a gravity dam may be influenced adversely by excessive uplift on its base, on lift joints, and/or on foundation planes. In massive unreinforced concrete structures such as dams, cracks are likely to occur. Overstressing may cause cracks in the dam or its foundation. Because dams are hydraulic structures, in many cases water will enter and pass through the cracks. The performance of an arch dam is highly dependent on the extent of deformation in its abutments under the range of applied loads. A buttress dam particularly may suffer from overstressing accompanying natural deterioration of its thin structural members. Structural behavior, design criteria, and shear stresses are factors influencing overstressing of arch dams through shear forces. Examples are presented of shear forces that have induced tensile cracks. Remedial measures include grouting cracks or facings with portland cement, asphalt, or synthetics; buttress strengthening; or installation of anchors. Many concrete dams have been damaged by the effects of alkali/aggregate reaction. Concrete addition and drainage are remedial measures for this type of damage. Numerous case histories of remedial procedures are given. (See also W89-05687) (Shidler-PTT)
W89-05719

SPILLWAY DESIGN AND CONSTRUCTION: GENERAL CONSIDERATIONS,
E. T. Scherich.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 609-611, 645, 2 ref.

Descriptors: *Hydraulic structures, *Spillways, *Design criteria, *Overflow channels, *Dam design, Spillway gates, Chutes, Stilling basins, Baffles, Topography, Hydrologic data, Project planning, Design flood.

Spillways may be classified according to their function as service (normal and flood releases), auxiliary (infrequent use), or emergency (reserve protection against overtopping) spillways. Spillways generally have three kinds of components--conveyance, control, and terminal structures. Conveyance structure types are chute, conduit, tunnel, or free-fall. Control structures may be gated or ungated. Terminal structures include many types: hydraulic-jump or roller-bucket stilling basins; flip, deflector, or dispersion buckets; plunge basin or pool; combination hydraulic jump and flip bucket; baffled apron or chute; and direct discharge. The normal general data requirements for the design of spillways include topographical data, climatic data, hydrologic data, geological and seismological data, project requirements, flood-detention capacity, hydraulic data, structural data, water-quality data, special requirements, and downstream development. The design flood is the flood hydrograph used in the design of a dam and its appurtenant works, particularly for sizing the spillway and outlet works, and for determining maximum temporary storage (surcharge) and dam-height requirements. With respect to the maximum water surface, which is at the top of the surcharge storage space, freeboard provides a margin of safety against overtopping failure of a dam. (See also W89-05687) (Shidler-PTT)
W89-05720

SPILLWAY DESIGN AND CONSTRUCTION: SELECTION CRITERIA AND PROCEDURE,
E. T. Scherich.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 612-613.

Descriptors: *Dam design, *Hydraulic structures, *Spillways, *Design criteria, *Project planning, Hydrologic properties, Economic aspects, Design floods, Reservoir releases, Flood forecasting, Operating policies, Safety, Flood routing, Economic evaluation.

Selecting the proper spillway for a particular site is extremely important. Certain types of components and combinations of components have been developed to satisfy project requirements, site conditions, and hydrologic conditions. Reliability requirements must be satisfied, and economic considerations must be evaluated. Spillways should satisfy their primary function of satisfactorily and safely conveying the design flood and other reservoir releases to a discharge point downstream from the dam. Economic factors, project requirements, site conditions, reliability, accuracy of flood estimation, type of dam, frequency and duration of operation, and other factors should be considered in the selection process. Spillway selection criteria can be separated into functional considerations and safety considerations. A systematic procedure should be used for spillway selection. A step-by-step approach will facilitate the selection and sizing of components. Suggested steps include the following: (1) determine outflow and surcharge to accommodate the design flood; (2) select preliminary alternatives, and perform additional flood routings; (3) combine components; (4) perform an economic study; and (5) select the most-suitable spillway and other release facilities. (See also W89-05687) (Shidler-PTT)
W89-05721

SPILLWAY DESIGN AND CONSTRUCTION: HYDRAULIC DESIGN CONSIDERATIONS,
Corps of Engineers, Seattle, WA. Hydraulics Section.
R. P. Regan, and E. T. Scherich.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 613-618, 2 fig.

Descriptors: *Dam design, *Hydraulic structures, *Hydraulic design, *Design criteria, *Spillways, Safety, Hydraulic engineering, Spillway crests, Erosion control, Spillway gates, Conveyance structures, Chutes, Conduits, Tunnels.

Spillways are designed to carry large floods through a project without endangering the safety of the dam and associated structures and without incurring unacceptable damage either upstream or downstream from the spillway. Hydraulic considerations deal primarily with providing a high-efficiency spillway and yet producing a safe, low-

maintenance structure; the crest shape must provide high discharge coefficients and fairly uniform and predictable pressures on the crest. The spillway approach configuration will influence the abutment contraction coefficient, the nappe profile, and possibly the flow characteristics throughout the spillway chute and stilling basin. Exit channels should be designed to control erosion at an acceptable level. Control structures may be gated or ungated and may be located at the surface of a reservoir, or the control may be submerged for an orifice spillway. For gated spillways, careful consideration should be given to gate operation provisions, such as power supply, hoist type, and hoist controls (manual or automatic). Conveyance structures may consist of chutes, conduits, tunnels, and combinations of these structures. Designs for conduit and tunnel spillways ordinarily should avoid the formation of a hydraulic jump in the conduit or tunnel. A spillway conveyance structure may terminate with or without a constructed energy dissipator. (See also W89-05687) (Shidler-PTT)
W89-05722

SPILLWAY DESIGN AND CONSTRUCTION: STRUCTURAL DESIGN CONSIDERATIONS,
E. T. Scherich.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 618-620.

Descriptors: *Dam design, *Hydraulic structures, *Spillways, *Design criteria, *Structural engineering, Stress, Hydraulic design, Overflow, Embankments, Chutes, Tunnels, Concrete technology, Erosion control, Energy dissipation.

The structural design of spillways involves consideration of several factors that influence structural stability, internal stresses, and structural performance. State-of-the-art methods should be used for structural design. Approach and exit channels are designed primarily to satisfy hydraulic requirements. Control structures must be designed to withstand all appropriate dead, static live, and dynamic live loadings that apply to a particular site. In many cases, especially in wide valleys, the spillway is a concrete gravity overflow section flanked by nonoverflow sections with wraparound embankments. Chutes, conduits, and tunnels are designed by conventional methods to withstand various loads and combinations of loads. The design of structural details should be carefully performed, with particular care directed to the proportioning of structures, joints in the concrete (configurations, waterstops, joint fillers, dowels), continuity of reinforcement through joints where specified, concrete tolerances and finishes, provisions for flow aeration, provisions for expansion and contraction, drain outlets and vent intakes, and thermal insulation. It is essential that terminal structures of all types be designed to protect the dam and downstream structures from damage. Erosion of energy dissipators by abrasive material has been a persistent problem. (See also W89-05687) (Shidler-PTT)
W89-05723

SPILLWAY DESIGN AND CONSTRUCTION: SPECIAL DESIGN CONSIDERATIONS--CAVITATION AND AERATION,
N. L. S. Pinto.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 620-634, 645-646, 22 fig, 1 tab, 21 ref.

Descriptors: *Hydraulic design, *Design criteria, *Spillways, *Cavitation, *Dam design, *Aeration, *Fluid dynamics, Fluid flow, Air entrainment, Aerators, Boundary processes, Damage, Chutes, Hydraulic geometry, Mathematical equations.

Cavitation occurs in flowing water when a reduction of pressure within the liquid leads to a change of phase from liquid to vapor. The vapor and/or vapor and gas nuclei grow rapidly, forming visible cavities in the fluid. The sudden collapse of the cavities generates intense pressure-shock waves, which are responsible for the noise and eventual damage associated with cavitation. Experimental investigations of aeration effects indicate that an air concentration of 5 to 10% near the surface to be protected practically eliminates cavitation risks. Ramps or steps inserted on the chute surface are the simplest and most practical devices used to cause natural aeration of water flow near a solid boundary. Designing an aeration system involves three main considerations: (1) The location of the first aerator, (2) the volume of air entrained at the aerator, and (3) the spacing between aerators to maintain a given protection level. Definition of the ideal proportions of the different parts of the aeration device constitutes one of the fundamental design problems. As a practical tool for design purposes an equation describing the performance of an aerator is developed. This relationship is based on air entrained by water per unit width of chute, average water velocity, water depth normal to the flow, water jet length, and an empirical aerator coefficient. (See also W89-05687) (Shidler-PTT)
W89-05724

SPILLWAY DESIGN AND CONSTRUCTION: SPECIAL DESIGN CONSIDERATIONS--CAVITATION PROTECTION OF SPILLWAY CRESTS,
Corps of Engineers, Seattle, WA. Hydraulics Section.
R. P. Regan.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 634, 646, 1 ref.

Descriptors: *Dam design, *Hydraulic design, *Design criteria, *Spillways, *Spillway crests, *Cavitation, Flow discharge, Boundary processes, Pressure head, Atmospheric pressure.

Free discharge over an elliptical/ogee crest will develop pressures on the concrete boundary somewhat inversely proportional to the energy head to design head ratio. When the ratio is nearly one, the pressures on the crest boundary are essentially atmospheric; as it increases, crest pressures will drop below atmospheric. Cavitation on an ogee crest would be incipient at an average pressure of about -25 ft (-7.62 m). A spillway crest should be designed so that the maximum expected head will result in a average pressure on the crest no lower than -20 ft (-6.1 m) of water. (See also W89-05687) (Shidler-PTT)
W89-05725

SPILLWAY DESIGN AND CONSTRUCTION: SPECIAL DESIGN CONSIDERATIONS--ABRASION OF FLOW SURFACES,
E. T. Scherich.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 634-635, 646, 1 fig, 1 ref.

Descriptors: *Dam design, *Erosion, *Hydraulic design, *Design criteria, *Spillways, *Abrasion, *Concrete construction, Damage, Stilling basins, Design flow, Tailwater, Hydraulic jump, Rocks, Maintenance, Cavitation, Model testing.

Flow-surface abrasion ranks high among problems associated with spillways. Examination of abrasion damage to prototype stilling basins has shown that damage can occur for discharges much smaller than the design discharge, especially where a high tailwater causes the jump to form on the sloping chute approach to the horizontal floor of the basin. In hydraulic-jump stilling basins the abrasive action has been by circulation of rocks, gravel, and sand, and also the debris left in the stilling basin after construction. In some instances rocks have been thrown into the basins by visitors. The depth of erosion may be several feet. The severe erosion by abrasion of hydraulic-jump-type stilling basins has caused many dam owners to perform underwater inspection and removal of debris as a routine maintenance procedure. Also, where concrete damage occurs in high-velocity areas of stilling basins, cavitation may be triggered, increasing erosion conditions. Certain basin configurations appear to be more subject to circulation of sand and rocks than others. Designers should include self-cleaning characteristics along with other considerations in selecting basin types and in designing end sills. Some model testing has been done to alleviate the abrasion problem for existing stilling basins. (See also W89-05687) (Shidler-PTT)
W89-05726

SPILLWAY DESIGN AND CONSTRUCTION: SPECIAL DESIGN CONSIDERATIONS--CHANNEL EROSION,
J. Lowe, and E. T. Scherich.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 635-636, 646, 6 ref.

Descriptors: *Dam design, *Scour, *Erosion, *Hydraulic design, *Design criteria, *Spillways, *Channel erosion, Structural engineering, Tailwater, Energy dissipation, Canyons, Hydroelectric plants, Outlets, Hydraulic models.

Channel erosion is routinely considered in the hydraulic and structural design of approach and exit channels. The most appropriate solution to the problem of releasing high-velocity flows to a downstream channel may be a type of flip bucket that will project the flow as far as possible from structures that may be vulnerable to undercutting by high-energy flows. In the case of flip buckets that are located above the tailwater, the flow is projected into the air, and the dissipation of energy takes place in the area of impact, in contrast to submerged buckets that relay on a roller action to dissipate the flow energy. In narrow canyons where the normal releases to the river by a hydroplant or other outlet works produce large tailwater depths, the water depth and river volume may provide adequate energy dissipation to prevent excessive channel erosion. The location and dimensions of scour holes and constructed plunge basins can be determined by empirical equations and data developed by hydraulic modeling and confirmed by prototype operating experience. One formula for determining the depth of scour holes is Veronese's formula, which was developed for a plunge pool resulting from the jet of a free-fall spillway. It is interesting to note that the depth of scour is much more dependent on unit discharge than on the difference in head between reservoir and tailwater. (See also W89-05687) (Shidler-PTT)
W89-05727

SPILLWAY DESIGN AND CONSTRUCTION: SPECIAL DESIGN CONSIDERATIONS--SEEPAGE, UPLIFT, AND STRUCTURAL STABILITY,
J. Lowe.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 636-642, 5 fig.

Descriptors: *Hydraulic design, *Design criteria, *Spillways, *Seepage, *Dam design, *Uplift pressure, *Stability analysis, Pipe flow, Drainage, Grouting, Cutoffs, Foundation rocks, Drainage systems, Chutes.

Seepage through, under, and around spillways and outlets has serious implications with respect to structural stability, implications such as uplift and lateral water pressure loadings, piping of fine-grained materials from structure foundations and backfill or from the embankment adjacent to the structures, and solutioning and movement of soluble materials from structure foundations. Reduction in uplift for a control structure is generally accomplished by placing a drainage curtain near the upstream end of the control structure. In order to prevent high gradients to the drainage curtain and possibly large quantities of seepage, either a grout curtain, an impervious cutoff, an upstream impervious blanket, or some combination of these features is installed upstream of the drainage curtain. If the foundation for the control structure is rock with seams and/or joints filled with fine sand or silt, grouting is not practicable. Where foundations contain erodible material, drain holes should be provided with filters to prevent any loss of material. Cutoffs are provided to reduce the quantity of seepage and to compartmentalize seepage in

order that a drainage system can be effective in reducing uplift pressures. The floor slabs of spillway chutes should be provided with underdrains in case any leakage occurs through joints or cracks in the chute. (See also W89-05687) (Shidler-PTT)
W89-05728

SPILLWAY DESIGN AND CONSTRUCTION: SPECIAL DESIGN CONSIDERATIONS--STABILITY OF STRUCTURES,
E. T. Scherich.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 642.

Descriptors: *Dam design, *Hydraulic design, *Design criteria, *Spillways, *Stability analysis, Earthquake engineering, Chutes, Water pressure, Uplift pressure.

Special consideration should be given to seismic loadings, dynamic water loadings, and uplift loadings. The structural components of spillways usually resist seismic loadings without special strengthening measures, but the upper portions of high retaining walls may require additional reinforcement over that required for static loadings. Designing floor blocks and dentated sills of chutes and stilling basins to resist dynamic loading is quite straightforward, as it is for similar loadings on flip buckets. Uplift loadings under energy-dissipator floor slabs require special attention where high-energy flow conditions will exist. (See also W89-05687) (Shidler-PTT)
W89-05729

SPILLWAY DESIGN AND CONSTRUCTION: CONSTRUCTION CONSIDERATIONS,
E. K. Schrader.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 642-646, 9 ref.

Descriptors: *Dam construction, *Hydraulic design, *Spillways, *Construction methods, *Concrete technology, Design standards, Cements, Curing, Hydration, Concrete mixes, Materials engineering, Polymers, Aggregates, Compaction, Dam construction, Flow velocity.

Designers should avoid requiring tolerances that are not practical, or they must be willing to pay the price in time and money to achieve them when they are actually needed. Contractors should not be expected to account for dimensional changes due to internal heat from hydration of cement, drying shrinkage, and bleeding settlement. The designer should share responsibility for mixture proportioning, from both the practicality of placing and material-strength standpoints. A major problem with surface tolerance which is often overlooked by designers is how that tolerance is achieved. Overworking the concrete during placement can give a better tolerance, but will also result in a softer surface. Grinding to remove excess undulations and abrupt offsets can also be detrimental. Patching needs much more attention than it has been given in the past. One of the newer developments with great promise for repair work is the use of polymers in concrete. Prepackaged monomer systems that contain the monomer fluid and aggregate fillers are now available. The development of roller-compacted concrete (RCC) has been a relatively recent occurrence which has provided a popular method of dam construction. However, until more experience is accumulated under operating conditions, especially at high velocities and for long durations, the use of RCC for spillways should be very cautiously evaluated. (See also W89-05687) (Shidler-PTT)
W89-05730

SPILLWAY PERFORMANCE AND REMEDIAL MEASURES: IDENTIFICATION AND CATEGORIZATION OF CAUSES OF MALPERFORMANCE,
E. T. Scherich.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 647-648.

Descriptors: *Spillway performance, *Dam performance, *Spillways, *Performance evaluation, *Rehabilitation, *Hydraulic engineering, *Spillway capacity, Structural behavior, Mechanical failure.

Operating experience with spillways for dams has revealed problems of two general types: (1) inadequate capacity and (2) unsatisfactory performance for design or less-than-design discharges. Specific spillway deficiencies that could compromise the safety of a dam can be categorized as hydrologic, geological and seismic, hydraulic, structural, or operational. From these categories, the major problem areas are: (1) inadequate spillway capacity; (2) failure of flow surfaces due to cavitation and abrasion; (3) structural failure because of inadequate foundation treatment and failure to prevent excessive uplift pressures; (4) structural failure caused by dynamic loadings; and (5) failure of operating provisions, hoists, and hoist controls or gate malfunction. (See also W89-05687) (Shidler-PTT)
W89-05731

SPILLWAY PERFORMANCE AND REMEDIAL MEASURES: EXAMPLES AND CASE HISTORIES OF MALPERFORMANCE--CAVITATION AND ABRASION DAMAGE TO CONCRETE FLOW SURFACES,
E. K. Schrader.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 648-653, 3 fig.

Descriptors: *Dam performance, *Spillway performance, *Spillways, *Performance evaluation, *Rehabilitation, *Cavitation, *Abrasion, *Concrete technology, Damage, Outlets, Maintenance, Case studies.

Damage to concrete flow surfaces by cavitation and abrasion is a common occurrence in spillways and outlet works. Usually operation of these structures can continue until repairs can be made, but in some cases severe operational limitations must be imposed. The following examples of cavitation and abrasion damage are described: (1) McNary Dam, Oregon--erosion of stilling basin floor; (2) Dworshak Dam, Idaho--debris erosion of stilling basin and cavitation erosion of outlets; (3) Lower Monumental Dam, Washington State--erosion of discharge culverts and downstream rock channel; (4) Libby Dam, Montana--cavitation damage to outlets and debris-abrasion and cavitation damage to stilling basin; (5) Rathbun Dam, Iowa--stilling basin abrasion; (6) Kentucky Dam, Kentucky--stilling basin abrasion; (7) Ilha Soltiera Dam, Brazil--stilling basin erosion; (8) Guri Dam, Venezuela--cavitation damage to spillway flip bucket; (9) Madden Dam, Panama--cavitation damage to conduits; and (10) Karnaphuli Dam, Bangladesh--abrasion and cavitation damage to spillway and stilling basin. (See also W89-05687) (Shidler-PTT)
W89-05732

SPILLWAY PERFORMANCE AND REMEDIAL MEASURES: EXAMPLES AND CASE HISTORIES OF MALPERFORMANCE--BEHAVIOR OF THE IGUACU RIVER CHUTE SPILLWAYS,
N. L. S. Pinto.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 653-662, 684-685, 16 fig, 2 tab, 3 ref.

Descriptors: *Dam performance, *Spillway performance, *Spillways, *Performance evaluation, *Rehabilitation, *Chutes, Brazil, Hydroelectric plants, Historic floods, Radial gates, Spillway capacity, Aerators, Standing waves, Tailrace, Channel erosion, Cavitation, Hydraulic geometry.

The Iguacu River in South Brazil will develop about 10,000 MW of hydropower in six powerplants. Three of them, Foz do Areia, 2510 MW (1980), Santiago, 2000 MW (1980), and Osorio, 1050 MW (1975), have operated rather frequently under flood conditions, including the exceptionally high July 1983 flood, estimated to be of about 1:500-year to 1:1000-year recurrence. The three projects are provided with straight-chute spillways controlled by radial gates. During the July 1983 flood the Foz do Areia spillway operated almost at nominal capacity, with fully open gates and reservoir 1.6 ft (50 cm) below maximum normal water level. The aeration system to prevent cavitation worked perfectly. Downstream from the plunge pool 16-ft (5-m)-high waves were observed extending to the tailrace channel and were responsible for a broken powerhouse window located about 5 m above average tailwater level. The plunge pool pre-excavated bottom was checked after the 1983 flood and found to be at 1.0 m below design level. Santiago spillway operating conditions during the 1983 flood were excellent. Osorio spillway No. 2 operated at full capacity during the July 1983 flood. Slight cavitation had been detected at the flip bucket lip prior to July 1983 and had been repaired. The problem is attributed to the geometry of the of the flip bucket and recurred moderately in the July high flood flows. (See also W89-05687) (Shidler-PTT)
W89-05733

SPILLWAY PERFORMANCE AND REMEDIAL MEASURES: EXAMPLES AND CASE HISTORIES OF MALPERFORMANCE--CAVITATION DAMAGE IN SHORT STILLING BASINS,
N. L. S. Pinto.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 662-665, 685, 13 fig, 2 ref.

Descriptors: *Spill way performance, *Dam performance, *Spillways, *Performance evaluation, *Rehabilitation, *Cavitation, *Stilling basins, Energy dissipation, Radial gates, Bedrock, Hydraulic jump, Foundation rocks, Scour, Damage, Hydraulic models, Vortices, Piers, Hydraulic design.

Short stilling basins are sometimes used as energy dissipators when the rock is sufficiently competent to resist the high residual kinetic energy of the flow. A 25-m-high spillway, controlled by ten 13.0-m by 12.5-meter radial gates built in 1975, was designed to discharge in a classical 25-m-long stilling basin. The 50-cm-thick basin slab rested on a layer of gravel with no anchorage to the sound granite bedrock. Pressure fluctuations due to the hydraulic jump lifted the slabs, which were picked up by the shooting flow and moved downstream. Emergency repairs included a 2.0-m-wide toe beam, anchored to the foundation to inhibit backscouring. After ten months of operation, cavitation damages were detected along the downstream face of the toe slab. Hydraulic model tests carried out in a 1:50 scale sectional model demonstrated cavitation pressures to be related to asymmetric gate operation. When one adjacent gate is closed, strong vortices develop at the zone downstream from the piers. The problem was overcome by the construction of a short basin anchored to the rock. After about ten years of operation, moderate cavitation pitting was observed all along the horizontal end sill and along the curved vertical surface at the downstream end of the piers. In planned repair work, the piers will be straightened out to maintain parallel flow throughout the structure, and the end sill will be inclined downstream. (See also W89-05687) (Shidler-PTT)
W89-05734

SPILLWAY PERFORMANCE AND REMEDIAL MEASURES: EXAMPLES AND CASE HISTORIES OF MALPERFORMANCE--CAVITATION DAMAGE AND REPAIR OF GLEN CANYON DAM SPILLWAY TUNNELS,
Bureau of Reclamation, Denver, CO. Hydraulics Branch.
P. H. Burgi.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 665-678, 685, 5 fig, 1 tab, 3 ref.

Descriptors: *Spillways, *Performance evaluation, *Rehabilitation, *Spillway performance, *Flood damage, *Dam performance, *Cavitation, *Tunnels, Channel flow, Radial gates, Flood flow, In-

spection, Model studies, Aerators, Hydraulic design, Backfill.

The tunnel spillways at Glen Canyon Dam are open channel flow type with two 40-ft by 52.5-ft radial gates to control releases to each tunnel. In 1983 the spillways were required to pass the summer flood on the Colorado River. In early August, the tunnel spillways were dewatered, and as engineers entered the left tunnel, it was obvious that serious damage had occurred. Immediately downstream from the point of tangency of the vertical bend, a hole 35 ft deep, 134 ft long, and 50 ft wide had been excavated in the sandstone by the high-energy flow. Inspection of the right tunnel spillway revealed less damage. However, a large hole was found in the tunnel invert immediately downstream of the bend point of the tangency. Laboratory model studies were performed to develop an aeration slot similar to the design used in 1968 at Yellowtail Dam. The Glen Canyon Dam slot design consists of a short length of ramp to lift the water over the air-supply slot and prevent the slot from filling with water. The repair work in the Glen Canyon Dam spillways included backfilling the large hole downstream of the elbow, replacing portions of the entire circular cross section, repairing areas where major damage had occurred in the spillway elbows, and repairing less severe damage to the inverts and tremie concrete placement downstream of the left spillway bucket. (See also W89-05687) (Shidler-PTT)
W89-05735

SPILLWAY PERFORMANCE AND REMEDIAL MEASURES: REMEDIAL MEASURES--INCREASING SPILLWAY CAPACITY,
Corps of Engineers, Seattle, WA. Hydraulics Section.
R. P. Regan, D. L. Hinchliff, P. G. Grey, and E. W. Gray.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 678-685, 7 fig, 14 ref.

Descriptors: *Spillway performance, *Dam performance, *Spillways, *Weirs, *Flood protection, *Performance evaluation, *Rehabilitation, *Spillway capacity, Spillway crests, Hydraulic geometry, Geomembranes, Linings, Earthworks, Embankments.

The capacity of an existing spillway may be increased by the following methods: (1) increasing the approach channel efficiency; (2) reshaping the abutments and/or piers to increase the efficiency of the discharge characteristics; (3) lowering the spillway crest or increasing the head on the crest; (4) lengthening the spillway crest; or (5) reshaping the crest to increase the coefficient of discharge. An innovative and effective way of increasing the spillway capacity (crest length) at a dam is to use a labyrinth weir. The distinguishing characteristic of these spillways is that the plan shape is not linear but varies, using a repeating planform, usually 'U', 'V', or trapezoidal shapes. Another method to increase spillway capacity is to construct an entirely new additional spillway. A flexible membrane (also referred to as a geomembrane) lining has been used in a small-scale study of an emergency spillway of Cottonwood Dam No. 5 (Colorado). The basic concept is that a low-cost spillway, consisting of a geomembrane-lined earth structure, could be constructed on or adjacent to the dam embankment. An auxiliary spillway with a fuse plug embankment is well suited for providing additional evacuation capacity in conjunction with the occurrence of a low-probability flood. An erodible embankment, the fuse plug is made either of homogeneous or zoned material with an impervious core. (See also W89-05687) (Shidler-PTT)
W89-05736

SPILLWAY PERFORMANCE AND REMEDIAL MEASURES: REMEDIAL MEASURES--CAVITATION PREVENTION,
E. T. Scherich.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 684, 1 fig.

Descriptors: *Spillway performance, *Dam performance, *Spillways, *Performance evaluation, *Rehabilitation, *Cavitation, Flow velocity, Erosion damage, Aerators, Aeration, Hydraulic design, Hydraulic models.

Cavitation of surfaces subjected to high-velocity flow is a common occurrence. Existing structures that have been damaged by cavitation erosion and those that could be so damaged if high-velocity, long-duration flows were to occur, should be retrofitted with aeration devices. It is essential that damaged flow surfaces be properly repaired using the most advanced techniques and materials. From the considerable, well-documented experience that has been acquired in the last several years, aeration of high-velocity flow surfaces has been demonstrated to be the best method for prevention of cavitation. However, this experience also shows that certain construction details conducive to initiation of localized low-pressure areas should be given careful consideration by the design engineer. Hydraulic models should be used to develop or confirm the designs of aeration devices not identical or nearly identical to those previously tested. (See also W89-05687) (Shidler-PTT)
W89-05737

OUTLET DESIGN AND CONSTRUCTION,
R. B. Jansen, R. P. Regan, and E. T. Scherich.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 686-703, 5 fig, 6 ref.

Descriptors: *Outlets, *Gates, *Conveyance structures, *Hydraulic design, *Intakes, *Dam construction, Design criteria, Structural engineering, Safety, Economic aspects, Inlets, Outlet channels, Conveyance structures, Pressure head, Flow velocity.

General design and construction considerations for dam outlets are presented, with particular emphasis on advanced concepts and methodology and malperformance-preventing design measures. Selection criteria and procedure, hydraulic and structural design considerations, and special design and construction considerations are discussed. The selection of appropriate outlet components is essential for reasons of safety, operating effectiveness, and economics. The procedure for selecting outlet types and components should be systematic to avoid needless changes in concepts as requirements are being satisfied. The design effort for outlets can be reduced by simultaneous consideration of hydraulic and structural requirements and construction limitations. Using a combined process, starting with the conceptualization stage, extremely difficult structural design problems, and possibly redesign, can be avoided, with considerable savings of time and effort. Components whose hydraulic design is considered include inlet and outlet channels, intakes, gate chambers and shafts, and conveyance, control, and terminal structures. Structural design considerations are described for these components and also for gates, valves, and downstream control structures. Problems requiring special treatment are generally associated with either high-head or high-velocity water-flow conditions. (See also W89-05687) (Shidler-PTT)
W89-05738

OUTLET PERFORMANCE AND REMEDIAL MEASURES: IDENTIFICATION AND CATEGORIZATION OF CAUSES OF MALPERFORMANCE,
E. T. Scherich.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 704-705.

Descriptors: *Outlet performance, *Dam performance, *Outlets, *Performance evaluation, *Rehabilitation, *Stability analysis, *Mechanical failure, Spillways, Design discharge, Cavitation, Abrasion, Energy dissipation.

Many problems are common to both spillways and outlets. Problems of outlets usually are discovered earlier in their operating life than spillway problems because outlets operate close to design discharges as soon as the reservoir fills to the top of active conservation capacity (the normal water surface). Problems associated with high-energy flow conditions have been the most severe--cavitation, erosion of concrete surfaces by abrasion, vibration damage, and inadequate energy dissipation. Other problems have involved seepage, stability, excessive settlement, maloperation of gates and valves, fatigue failures due to vibration, deformation and buckling of steel liners of waterways, catapulting of gates, air blows, slug flow, tunneling in soft ground, and sediment encroachment on intakes. The state of the art in this area has progressed so that satisfactory prototype performance is reasonably ensured if proper design and construction measures are taken. (See also W89-05687) (Shidler-PTT)
W89-05739

OUTLET PERFORMANCE AND REMEDIAL MEASURES: EXAMPLES, CASE HISTORIES, AND REMEDIAL MEASURES,
E. T. S. R. P. Regan, E. K. Schrader, P. H. Burgi, and R. B. Jansen.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 705-719, 721, 12 fig, 9 ref.

Descriptors: *Outlets, *Performance evaluation, *Damage, *Rehabilitation, *Case studies, Cavitation, Aeration, Abrasion, Sluices, Tunnels, Stilling basins.

Cavitation and abrasion erosion associated with high-velocity flow have been the most severe and most frequent problem areas for outlet works. After sluice cavitation damage was detected at Libby Dam (Montana), prototype and model studies indicated that the most practical method for reducing cavitation pressures would be a device to allow air to be insufflated into the flow along the boundaries. The invert of the tunnel at Mud Mountain Dam (Washington) is lined with longitudinally-placed 40-lb rails and the space between the rails is grouted with a small-size, hard-aggregate, high-strength concrete. Considerable damage to the protection occurs, but analyses have shown that semiannual tunnel invert repair and reconstruction are at present the most economical solutions for this problem. Case histories of cavitation and abrasion damage to concrete flow surfaces at Lucky Peak Dam (Idaho), Painted Rock Dam (Montana), and Pomona Dam (Kansas) are presented. Other types of malperformance and remedial measures described include aeration downstream for high-pressure gates, abrasion damage in hollow-jet stilling basins, trashrack vibration at Edward Hyatt powerplant (California), intake structure turbulence at New Bullards Bar Dam (California), catapulting of gates, air blows in outlets, slug flow in conduits, and an example of tunnel construction problems. (See also W89-05687) (Shidler-PTT)
W89-05740

OUTLET PERFORMANCE AND REMEDIAL MEASURES: SUMMARY OF REMEDIAL MEASURES,
E. T. Scherich.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 719-721, 1 tab.

Descriptors: *Dam performance, *Outlet performance, *Outlets, *Performance evaluation, *Rehabilitation, *Reservoir operation, Damage, Cavitation, Aeration, Aerators, Flow velocity, Dam design, Abrasion, Scour, Vibrations, Load distribution.

Several recurring problems can be identified that pose serious operating difficulties for reservoir outlets. Cavitation has received more attention than other causes of structural damage. The most effective way to prevent cavitation is aeration of the flow boundary in regions of high velocities. Aeration slots across the floor and, in some cases, up the sides of a waterway should be included in the initial design. Providing an air supply for aeration slots in existing conduits and sluices is usually

difficult and expensive, so an accurate estimate of the air requirement should be made. Abrasion is best prevented by eliminating its cause, which usually is circulation of abrasive materials in regions of flow turbulence. Scour of downstream channels can be controlled by using the proper hydraulic and structural design of terminal structures, outlet channels, and plunge pools, and by providing adequate protection to the outlet channel flow surfaces. Vibration damage can be prevented in many cases by proper design of structural members that can be excited by dynamic loads and fluctuating water pressures. Dynamic loads on outlet works structures can be accommodated by proper design and construction, provided their occurrence is recognized, and their magnitudes are determined. In some cases, dynamic loads can be avoided by adopting an alternative design. (See also W89-05687) (Shidler-PTT)
W89-05741

RESERVOIRS: LEAKAGE FROM RESERVOIRS,
For primary bibliographic entry see Field 2H.
W89-05742

RESERVOIRS: RESERVOIR PROBLEMS OTHER THAN LEAKAGE,
Kiersch Associates, Inc., Tucson, AZ.
For primary bibliographic entry see Field 2H.
W89-05743

INSTRUMENTATION,
For primary bibliographic entry see Field 8G.
W89-05744

SURVEILLANCE,
Construction Engineering Research Lab. (Army), Champaign, IL.
For primary bibliographic entry see Field 8G.
W89-05745

8B. Hydraulics

STABILITY DESIGN OF GRASS-LINED OPEN CHANNELS,
Agricultural Research Service, Stillwater, OK. Plant Science and Water Conservation Lab.
For primary bibliographic entry see Field 4D.
W89-04849

MICROCOMPUTER SOFTWARE FOR STORM DRAIN HYDRAULIC GRADELINE COMPUTATION,
Virginia Highway and Transportation Research Council, Charlottesville.
S. L. Yu, and J. Y. Li.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-157011. Price codes: A03 in paper copy, A01 in microfiche. September 1987. 43p, 19 fig, 5 ref. Contract HPR2363.

Descriptors: *Hydraulics, *Computer programs, *Storm drains, *Hydrologic models, Storm sewers, Drainage systems, PFP-HYDRA, Pipes.

Several storm sewer computer programs were reviewed and PFP-HYDRA, a component program of the Federal Highway Administration (FHWA) Pooled Fund Integrated Drainage Design Package, was found to be a good program for systems not under surcharge conditions. PFP-HYDRA has the following capabilities: (1) generating storm runoff using either Rational Formula or hydrological simulation techniques, (2) changing design criteria at any point in the system, (3) analyzing any kind of system using the programming-like command statements; and (4) providing cost estimates and financial analysis. The capability of PFP-HYDRA in the design of sewer systems has been enhanced by the addition of a hydraulic gradeline computation module so that engineers can determine the possibility of surface flooding during storm events by computing the hydraulic gradeline of a sewer system. It is recommended that the enhanced PFP-HYDRA be used as an initial step for the determination of the hydraulic gradeline of a sewer system. Although PFP-HYDRA does not give an explicit account of the pressurized flow situation, it gives an indication of the possibility of surcharging at particular pipes. (Lantz-PTT)
W89-04894

ROCK RIPRAP DESIGN FOR PROTECTION OF STREAM CHANNELS NEAR HIGHWAY STRUCTURES VOLUME 1--HYDRAULIC CHARACTERISTICS OF OPEN CHANNELS,
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 8A.
W89-04910

ROCK RIPRAP DESIGN FOR PROTECTION OF STREAM CHANNELS NEAR HIGHWAY STRUCTURES VOLUME 2--EVALUATION OF RIPRAP DESIGN PROCEDURES,
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 8A.
W89-04911

DISCHARGE RATINGS FOR CONTROL GATES AT MISSISSIPPI RIVER LOCK AND DAM 13, FULTON, ILLINOIS,
Geological Survey, Iowa City, IA. Water Resources Div.
A. J. Heinitz.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4134, 1986. 43p, 15 fig, 6 tab, 16 ref.

Descriptors: *Locks, *Dams, *Gates, *Flow discharge, *Mississippi River, *Stream gaging, *Illinois, *Discharge measurement, Orifice flow, Forebays, Tailwater.

The water level of the navigation pools on the Mississippi River are maintained by the operation of tainter and roller gates at the locks and dams. Discharge ratings for the gates on Lock and Dam 13, at Fullerton, Illinois, were developed from current-meter discharge measurements made in the forebays of the gate structures. Methodology is given to accurately compute the gate openings of the tainter gates. Discharge coefficients, in equations that express discharge as a function of tailwater head, forebay head, and height of gate opening, were determined for conditions of submerged-orifice and free-weir flow. A comparison of the rating discharges to the hydraulic-model rating discharges is given for submerged orifice flow for the tainter and roller gates. (Author's abstract)
W89-04916

DISCHARGE RATINGS FOR CONTROL GATES AT MISSISSIPPI RIVER LOCK AND DAM 12, BELLEVUE, IOWA,
Geological Survey, Iowa City, IA. Water Resources Div.
For primary bibliographic entry see Field 8A.
W89-04917

DISCHARGE RATINGS FOR CONTROL GATES AT MISSISSIPPI RIVER LOCK AND DAM 16, MUSCATINE, IOWA,
Geological Survey, Iowa City, IA. Water Resources Div.
For primary bibliographic entry see Field 8A.
W89-04918

DISCHARGE RATINGS FOR CONTROL GATES AT MISSISSIPPI RIVER LOCK AND DAM 22, SAVERTON, MISSOURI,
Geological Survey, Iowa City, IA. Water Resources Div.
For primary bibliographic entry see Field 8A.
W89-04919

DISCHARGE RATINGS FOR CONTROL STRUCTURES AT MCHENRY DAM ON THE FOX RIVER, ILLINOIS,
Geological Survey, Urbana, IL. Water Resources Div.
G. G. Fisk.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 87-4226, 1988. 24p, 10 fig, 6 tab, 2 ref.

Descriptors: *Discharge coefficient, *Fox River, *Illinois, *Flow discharge, *Flow measurement, *Dams, Weirs, Sluice gates, Spillway gates.

Twenty-three measurement of discharge were used to determine discharge ratings for the five adjustable sluice gates, spillway and fish ladder at McHenry Dam on the Fox River in Illinois. Discharge ratings were determined for free weir, free orifice, and submerged orifice flow regimes. Hydraulic conditions that identify flow regimes at McHenry Dam are defined by ratios between headwater depth (h1), tailwater depth (h3), and gate opening (hg). Flow under the sluice gates is identified as weir flow when the ratio of gate opening to headwater depth is greater than 0.73, and as orifice flow when hg/H1 is less than 0.73. Free orifice flow occurs when the ratio of tailwater depth to gate opening is less than 1.3, and submerged orifice flow occurs when h3/hg is greater than 1.3. Flow under the sluice gates is identified as free weir flow when the ratio of tailwater depth to headwater depth is less than 0.75, and as submerged weir flow when h3/h1 is greater than 0.75. Flow over the spillway is identified as free weir flow when the ratio of tailwater depth to headwater depth is less than 0.60, and as submerged weir flow when h3/h1 is greater than 0.60. Discharge coefficients to be used in equations to compute discharge for various hydraulic conditions were determined. Four discharge measurement, ranging from 169 to 2990 cu ft/sec, were used to define discharge coefficients that varies from 2.61 to 3.14 for free weir flow over the spillway. Nineteen discharge measurements, ranging from 180 to 4050 cu ft/sec, were used to define discharge coefficients for free weir, free orifice, and submerged orifice flow under the sluice gates. The average value of the discharge coefficient for free weir flow under the sluice gates is 3.17. Discharge coefficients for free orifice flow varied from 0.48 to 0.66 and the discharge coefficients for submerged orifice flow from the two measurements were 0.59 and 0.67. (Author's abstract)
W89-04968

DETERMINATION OF FLUID FLOW PROPERTIES FROM THE RESPONSE OF WATER LEVELS IN WELLS TO ATMOSPHERIC LOADING,
Geological Survey, Menlo Park, CA.
For primary bibliographic entry see Field 2F.
W89-05062

EFFECT OF WALLS IN MODELING FLOW THROUGH POROUS MEDIA,
Michigan State Univ., East Lansing. Dept. of Mechanical Engineering.
For primary bibliographic entry see Field 2F.
W89-05211

COMBINING OPEN CHANNEL FLOW AT RIGHT ANGLED JUNCTIONS,
Concordia Univ., Sir George Williams Campus, Montreal (Quebec).
A. S. Ramamurthy, L. B. Carballada, and D. M. Tran.
Journal of Hydraulic Engineering JHEND8, Vol. 114, No. 12, p 1449-1460, December 1988. 7 fig, 11 ref.

Descriptors: *Hydraulic models, *Open-channel flow, *Flow pattern, *Channel inflow, Hydraulic engineering, Momentum transfer, Flow characteristics, Influent water.

In combining open channel flow, the rise in the upstream flow depth due to the effect of lateral inflow from the branch channel can be significant. For right-angled, sharp-edged junctions of rectangular channels, a relation between the depth of

flow at the junction and the ratio of the lateral discharge to the total discharge is derived on the basis of the momentum principle. Using this relationship, one can predict the rise in flow depth when the undisturbed flow conditions in the channels are specified. In the proposed model, the contribution of the momentum transfer from the branch channel to the main channel is included, as this factor can be significant when the lateral discharge is relatively large. The proposed relationship is verified with the results of experiments related to combining flows for which the flow conditions downstream of the junction are both critical and unsubmerged. The study of combining flow at right angle junctions has a direct application in drainage network systems and river engineering. (Author's abstract)
W89-05212

TYPE CURVES FOR TWO-REGIME WELL FLOW,
Technical Univ. of Istanbul (Turkey). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2F.
W89-05213

AIR TRANSPORT IN VORTEX-FLOW DROP SHAFTS,
Iowa Univ., Iowa City. Dept. of Civil and Environmental Engineering.
S. C. Jain.
Journal of Hydraulic Engineering JHEND8, Vol. 114, No. 12, p 1485-1497, December 1988. 8 fig, 11 ref.

Descriptors: *Air entrainment, *Vertical flow, *Drop shafts, *Swirl number, *Vortices, Hydraulic jump, Hydraulic gradient, Hydraulic models, Bubbles.

The effect of swirl on air transport in a vertical drop shaft is described. Laboratory experiments on a vortex-flow drop shaft showed that most of the air is entrained in the annular hydraulic jump that is formed when the annular jet flow changed to the pipe-full flow. A significant portion of the air bubbles converged due to an inward pressure gradient toward the center of the drop shaft, coalesced to form large bubbles, and then rose toward the surface. A large number of air bubbles still were carried downstream for flow conditions where the jump occurred at the location of low circulation. The air transport rate down the drop shaft was virtually zero if the jump formed in the strong circulation flow-region. The theoretical analysis indicates that the amount of air transported downstream depends upon the swirl number. The air concentration decreases with the increase in the swirl number. (Author's abstract)
W89-05214

BAR FORM RESISTANCE IN GRAVEL-BED RIVERS,
University of East Anglia, Norwich (England). School of Environmental Sciences.
R. D. Hey.
Journal of Hydraulic Engineering JHEND8, Vol. 114, No. 12, p 1498-1508, December 1988. 1 fig, 1 tab, 20 ref..

Descriptors: *Alluvial channels, *Flow resistance, *Channel morphology, *River beds, *Gravel, *River flow, Nonuniform flow, Flow pattern, Hydraulic roughness, Hydraulic models, Resistance, Bar form resistance.

Resistance to flow in unvegetated gravel-bed rivers is basically dependent on the skin resistance, due to surface bed material, and bar form resistance, due to accelerations and decelerations in the flow between pools and riffles. Although flow is generally nonuniform, at riffle sections flow is locally uniform. It is these sections which principally control the velocity-depth characteristics of reach since hydraulic conditions in the pool result from the backwater effect of the riffle. Isolating the effect of bar forms on flow resistance is achieved by first establishing the roughness height of the surface bed material on the riffle. Overall resistance to flow, in terms of the total roughness height due to bed forms and grains for equivalent uniform flow, is determined from the riffle and reach average flow geometry and the grain roughness height. Differences between total and grain roughness heights define the bar form effect. Field data from 62 sites in the United Kingdom illustrate that at bankfull flow bar roughness heights are generally in the range 0-0.5 m, although values as high as 1.5 m are also observed. (Author's abstract)
W89-05215

METHOD FOR OPTIMAL DESIGN OF BRANCHED NETWORKS ON FLAT TERRAIN,
Asian Inst. of Tech., Bangkok (Thailand). Div. of Industrial Engineering and Management.
For primary bibliographic entry see Field 5F.
W89-05234

PREDICTING INTERNAL ROUGHNESS IN WATER MAINS,
Waterways Experiment Station, Vicksburg, MS.
For primary bibliographic entry see Field 8G.
W89-05245

TELEGRAPH CANYON CREEK CHANNEL IMPROVEMENT PROJECT, SAN DIEGO COUNTY, CALIFORNIA: HYDRAULIC MODEL INVESTIGATION,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 8A.
W89-05399

ABOUT THE NUMERICAL ANALYSIS OF DYNAMICS IN MULTI-COMPONENT-CONTINUA,
Hanover Univ. (Germany, F.R.).
T. Hartmann, and U. Meissner.
IN: Groundwater Flow and Quality Modelling. D. Reidel Publishing Co., Boston. 1988. p 539-546, 101 ref.

Descriptors: *Hydraulic properties, *Fluid dynamics, *Numerical analysis, *Seepage, Drainage, Groundwater movement, Mathematical models, Dikes, Hydraulic models, Hydraulic structures, Dam stability.

The theory of multi-component-continua is of special interest for the investigation of the stability of dams and dikes. In this field the phenomena of seepage flow, drainage with filter layers, liquefaction and consolidation occur under excitation by stationary and time dependent external forces. A unique theory of mixtures (soil, water, air) is necessary with regard to the internal interaction of stresses in order to perform a reliable numerical simulation of the transient flow and the dynamic deformations of solid material. Since 1984 relevant field data have been collected from hydraulic, natural-scale experiments in the large Wave Channel (length 300 m, depth 7 m, width 5 m) at the University of Hanover. Through the use of these data, numerical models can be calibrated with respect to laboratory studies. In general, the numerical models allow the investigation of a wide variety of related problems, especially in the optimization of sea dike structures. (See also W89-05465) (Author's abstract)
W89-05495

DETERMINISTIC NATURE OF FLOOD FREQUENCIES: SOME OBSERVATIONS,
Calgary Univ. (Alberta). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2A.
W89-05645

HYDROLOGY,
Pacific Gas and Electric Co., San Francisco, CA.
For primary bibliographic entry see Field 8A.
W89-05694

SPILLWAY DESIGN AND CONSTRUCTION: HYDRAULIC DESIGN CONSIDERATIONS,
Corps of Engineers, Seattle, WA. Hydraulics Section.
For primary bibliographic entry see Field 8A.
W89-05722

SPILLWAY DESIGN AND CONSTRUCTION: STRUCTURAL DESIGN CONSIDERATIONS,
For primary bibliographic entry see Field 8A.
W89-05723

SPILLWAY DESIGN AND CONSTRUCTION: SPECIAL DESIGN CONSIDERATIONS--CAVITATION AND AERATION,
For primary bibliographic entry see Field 8A.
W89-05724

SPILLWAY DESIGN AND CONSTRUCTION: SPECIAL DESIGN CONSIDERATIONS--CAVITATION PROTECTION OF SPILLWAY CRESTS,
Corps of Engineers, Seattle, WA. Hydraulics Section.
For primary bibliographic entry see Field 8A.
W89-05725

SPILLWAY DESIGN AND CONSTRUCTION: SPECIAL DESIGN CONSIDERATIONS--ABRASION OF FLOW SURFACES,
For primary bibliographic entry see Field 8A.
W89-05726

SPILLWAY PERFORMANCE AND REMEDIAL MEASURES: IDENTIFICATION AND CATEGORIZATION OF CAUSES OF MALPERFORMANCE,
For primary bibliographic entry see Field 8A.
W89-05731

SPILLWAY PERFORMANCE AND REMEDIAL MEASURES: EXAMPLES AND CASE HISTORIES OF MALPERFORMANCE--CAVITATION AND ABRASION DAMAGE TO CONCRETE FLOW SURFACES,
For primary bibliographic entry see Field 8A.
W89-05732

SPILLWAY PERFORMANCE AND REMEDIAL MEASURES: EXAMPLES AND CASE HISTORIES OF MALPERFORMANCE--BEHAVIOR OF THE IGUACU RIVER CHUTE SPILLWAYS,
For primary bibliographic entry see Field 8A.
W89-05733

SPILLWAY PERFORMANCE AND REMEDIAL MEASURES: EXAMPLES AND CASE HISTORIES OF MALPERFORMANCE--CAVITATION DAMAGE IN SHORT STILLING BASINS,
For primary bibliographic entry see Field 8A.
W89-05734

SPILLWAY PERFORMANCE AND REMEDIAL MEASURES: EXAMPLES AND CASE HISTORIES OF MALPERFORMANCE--CAVITATION DAMAGE AND REPAIR OF GLEN CANYON DAM SPILLWAY TUNNELS,
Bureau of Reclamation, Denver, CO. Hydraulics Branch.
For primary bibliographic entry see Field 8A.
W89-05735

SPILLWAY PERFORMANCE AND REMEDIAL MEASURES: REMEDIAL MEASURES--INCREASING SPILLWAY CAPACITY,
Corps of Engineers, Seattle, WA. Hydraulics Section.
For primary bibliographic entry see Field 8A.
W89-05736

SPILLWAY PERFORMANCE AND REMEDIAL MEASURES: REMEDIAL MEASURES--CAVITATION PREVENTION,
For primary bibliographic entry see Field 8A.

W89-05737

OUTLET DESIGN AND CONSTRUCTION,
For primary bibliographic entry see Field 8A.
W89-05738

NORTH LYNN DRAINAGE SCHEME: HYDRAULIC MODEL STUDIES,
British Hydromechanics Research Association, Cranfield (England).
M. W. Payne.
The British Hydromechanics Research Association, Bedford, England. Report No. RR 2168, March 1984. 17p, 8 fig.

Descriptors: *Drainage programs, *Open-channel flow, *Culvert flow, *Hydraulic models, *Hydraulic structure, *Culverts, Flow profiles, Channel morphology, Channel scour, Water surface profiles, Flow rates.

A hydraulic model of the existing culvert under Stone Bridge, King's Lynn, and the proposed upstream and downstream transitions and channels, was constructed to a scale of 1:15. The model represented all the relevant features including full channel lengths, bed slopes, divergence angles, bends and the downstream control structure. The purpose of the investigations was to measure water surface elevations through the system and in particular the head drop through the culvert, and to study the flow regimes and patterns over the full range of flow rates and control levels. Particular interest was paid to the river bed velocities in the downstream bend and channel with respect to the possibility of scour. (Lantz-PTT)
W89-05749

PRESSURE SURGE ANALYSIS OF PROPOSED CHEDDAR PUMPING STATION, BRENT KNOLL ZONE,
British Hydromechanics Research Association, Cranfield (England).
For primary bibliographic entry see Field 8C.
W89-05750

8C. Hydraulic Machinery

TAMING B.C. HYDRO: SITE C AND THE IMPLEMENTATION OF THE B.C. UTILITIES COMMISSION ACT,
University of Western Ontario, London. Dept. of Geography.
For primary bibliographic entry see Field 6E.
W89-05342

HYDROPNEUMATIC PUMP SYSTEM DEVELOPMENT,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
Y. Sternberg, and J. French.
Water and Sanitation for Health Project, Washington, DC. WASH Technical Report No. 23, April 1984. 63p, 1 tab, 3 append. AID Contract 5942-C-00-4085-00, Project 936-5942.

Descriptors: *Pumps, *Hydropneumatic pump, *Hydraulic machinery, *Developing countries, *Water conveyance, Water supply development, Mathematical models, Computer models, Model studies, Hydraulic equipment.

The concept of a hydropneumatic pump was investigated because it is potentially suitable for pumping water in remote areas using the energy of some of the water in the source stream. The pump can be built almost entirely out of oil drums and standard small-bare piping; it is self-priming; and except for two check valves there are no moving parts. The development of a system which could serve a community of 5,000 persons and provide each person with 20 gallons of water during a 10 hour period was studied. This included the development of a mathematical model as an aid to the design and construction of a functional prototype. It also included the construction of a full scale prototype model, which was limited inasmuch as it was not equipped for continuous operation and trial runs were restricted to fill and discharge batch runs without exploring the various parameters necessary for establishment of optimum scale and sizing of various components. Should the task be resumed, it is recommended that future studies with the physical model and the computer model include: (1) Completion and full commissioning of the physical model with modified siphon size or multiple alternate siphon piping; (2) Calibration and verification of the computer model; (3) A determination of the relationship between the amount of lift and discharge of low rate of the unit with a means for expressing this relationship; (4) Better definition of pump capacity as a function of component pipe diameters and lengths and other geometric parameters; (5) Through use of the prototype, study the secondary hydraulic questions not fully addressed in the computer model such as unstable flow, air counterflow, and assured siphon priming; and (6) An assessment of the range of applicability and the degree of utility of this type of pump. (Lantz-PTT)
W89-05520

OUTLET DESIGN AND CONSTRUCTION,
For primary bibliographic entry see Field 8A.
W89-05738

PRESSURE SURGE ANALYSIS OF PROPOSED CHEDDAR PUMPING STATION, BRENT KNOLL ZONE,
British Hydromechanics Research Association, Cranfield (England).
J. Boxer.
The British Hydromechanics Research Association, Bedford, England. Report No. RR 2169, March 1984. 29p, 11 ref, append.

Descriptors: *Scours, *Pressure distribution, *Pumping plants, Hydraulic profiles, Hydraulic models, Flow profiles, Simulation analysis, Pipe flow, Hydraulic design, Pumps.

An analysis has been carried out on the transient behavior of the Brent Knoll zone of Cheddar Pumping Station which is under design. Four cases of pump start-up and shut-down have been modeled and surge protection equipment has been specified to limit pressures to the prescribed limits. These have been taken as a maximum of 90 m gauge pressure and a minimum of about 10 m to prevent the air valves from opening, which is undesirable. One case, Case 1.1, was tested with an accumulator of approximately 19.5 cu m total volume, initial water volume of 6.9 cu m and an air volume of 12.6 cu m and a back feed into East Brent inlet pipe 3 m below pipe entry level. Minimum pressure upstream of the float valve should be limited to approximately 3 m gauge and maximum pressure in the line to 81.1 m at the pump delivery. Minimum pressures along the line should be limited to 8.5 m gage at node 23 (high spot in Brent Knoll Branch). This should be sufficient to prevent air valves from opening during the downsurge. The inflow and outflow cases used in this calculation have been based on a high loss between the accumulator and its connection to the delivery main at node 13. This is adequate to allow a considerable amount of pipework, fittings and a suitably sized orifice plate to be installed without reducing the flow available into and out of the accumulator during surge conditions. By using this high value there is flexibility in siting the accumulator, without having to worry about changing loss coefficients in the computer simulation. (Lantz-PTT)
W89-05750

8D. Soil Mechanics

ANALYSES OF DAM FAILURES IN 1985 CHILEAN EARTHQUAKE,
New Hampshire Univ., Durham. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8A.
W89-05344

GEOLOGY: LAND SUBSIDENCE,
For primary bibliographic entry see Field 8E.
W89-05697

MATERIALS: MATERIALS FOR EMBANKMENTS,
C. A. Fetzer.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 172-176,216, 1 fig, 9 ref.

Descriptors: *Construction materials, *Dam construction, *Earth dams, *Rockfill dams, *Embankments, Design criteria, Economic feasibility, Rock properties, Rock excavation, Slope protection, Soil cement, Asphaltic concrete, Drainage.

Embankments for water-retention purposes can be safely constructed from most available materials, provided the design properly takes into consideration their properties. To be economically viable, most embankments must utilize locally-available materials, with off-site items limited to specialty materials such as filters, drains, and riprap. Materials for rockfill embankments are considered to be hard rock fragments that do not break down substantially during placement and compaction, and remain essentially free-draining in the embankment with a high shearing strength. Rock-type materials obtained from stripping the foundation to firm rock and from trimming the abutments are usually contaminated with overburden and weathered rock; hence, these materials ordinarily cannot be used as rockfill, but could possibly be used in a random zone if stockpiling and double handling were cost-effective in comparison with other material sources. Quarry stone is the most commonly used slope protection for embankments. Cobbles and boulders are also used but lack the interlocking of quarried stone. Soil cement, concrete facing, and asphaltic concrete have been used in areas where the cost of stone protection is excessive. Filter and drainage materials are obtained mostly from commercial sources or from processing on-site materials through a screening and washing plant. (See also W89-05687) (Shidler-PTT)
W89-05700

MATERIALS: DISPERSIVE CLAYS,
Bureau of Reclamation, Denver, CO. Geothechnical Branch.
P. C. Knodel.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 176-182, 216-217, 3 fig, 40 ref.

Descriptors: *Construction materials, *Dam construction, *Earth dams, *Soil properties, *Clays, *Dam design, Erosion, Dam failure, Soil tests, Soil engineering, Filters, Impervious soils, Safety, Design criteria.

Dispersive clays are those clays with unique properties that under certain conditions deflocculate and are rapidly eroded and carried away by water flow. These properties can result in disastrous consequences for earthfill dams constructed with these materials. However, much is now known about the presence, properties, and tests for identification of dispersive clays and for their use in earthfill dams. With the present state of knowledge of dispersive clays, it is believed that no important changes are necessary in current practice for designing and constructing earth embankment dams. However, it is important for the engineer to be able to identify dispersive clays on a given project so that special care and attention can be given during design and construction to the critical areas in which they will be used. Recent research on filters has shown that dispersive clays can be safely and effectively used if well-designed filters are incorporated into the plan. Several major dams have been built in the last few years with impervious zones identified as dispersive clays. Safe dams can be built with dispersive-clay materials if certain precautions are taken. Precautions include, but are not limited to, proper moisture and density control, use of filters and filter drains, select placement of materials, use of sand/gravel blankets or lime-modified soil on

slopes, and chemical treatment of the clays. (See also W89-05687) (Shidler-PTT)
W89-05701

EARTHQUAKE RESPONSE ANALYSIS OF EMBANKMENT DAMS,
Woodward-Clyde Consultants, Oakland, CA.
For primary bibliographic entry see Field 8E.
W89-05708

EARTHFILL DAM CONSTRUCTION AND FOUNDATION TREATMENT,
C. A. Fetzer, W. F. Swiger, and R. W. Kramer.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 321-353, 19 fig, 4 tab, 33 ref.

Descriptors: *Dam construction, *Earth dams, *Dam foundations, *Engineering geology, *Construction methods, Dam design, Borrow pits, Grouting, Soil treatment, Soil compaction, Inspection, Quality control.

Variations in foundation conditions and borrow-area materials from the assumptions of geologists and designers during design-stage investigations should be expected. Uncertainties in the foundation and abutment conditions and in borrow materials have led to the conclusion that the design must continue through construction. Foundation treatment for an embankment dam may include general excavation, core-contact preparation on hard rock, core contacts on soft rocks and similar materials, drainage of foundations, surface preparation for the shell sections of the dam, dewatering, and foundation grouting. Treatment of collapsible foundation soils involves the addition of water to the soil to allow consolidation as the embankment is being constructed. Aspects of earthfill construction include operation of borrow sources, control of surface drainage, removal of the foundation dewatering system, initial lifts (layers of fill) on rock foundations, compaction against abutments and structures, compaction around instrumentation, placement of lifts, compaction control, compaction equipment, and utilization of instrumentation. The importance of adequate inspection and quality control in earth-dam construction cannot be overstated. In case there may be disputes and modifications, inspection and construction records should include construction history and as-built drawings. (See also W89-05687) (Shidler-PTT)
W89-05710

EARTHFILL DAM PERFORMANCE AND REMEDIAL MEASURES,
C. A. Fetzer, W. F. Swiger, J. G. Wulff, and R. W. Kramer.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 354-367, 7 fig, 1 tab, 14 ref.

Descriptors: *Dam safety, *Earth dams, *Dam stability, *Seepage, *Monitoring, *Embankments, Engineering personnel, Inspection, Early impoundment, On-site investigations, Dam failure, Cracks, Case studies.

Earth embankments are massive structures that inherently have movements and seepage. Analyses and comparative data should be used to establish acceptable benchmark norms; however, inspectors, instrumentation personnel, and evaluators should always be on the alert even before the benchmark norms are reached, for adverse trends in data plots, cracks, seepage concentrations, boils, evidence of piping, sinkholes, and other signs of distress. Monitoring of the initial filling of the reservoir should include a preparation stage, on-site inspection, validity-checking of instrumentation data, and daily data evaluation. As long as water is impounded in the reservoir, the potential exists for incidents to occur from slope failures due to saturation and/or drawdown, undermining, or piping failure from long-term seepage, and so on; hence, it is necessary to establish a continued long-term on-site monitoring and evaluation program to ensure the safety of the dam. Although not all dams can be saved after detrimental seepage is detected, many dams can be saved by quick and appropriate action. Seepage problems, cracking and slides, or settlement may require remedial action. Case histories of remedial measures at Mohicanville Dike No. 2, Logan Martin Dam, Calaveras Dam, and Lake Sherburne Dam (where reinforced earth was used to raise the dam crest) are presented. (See also W89-05687) (Shidler-PTT)
W89-05711

ROCKFILL DAM DESIGN AND ANALYSIS,
Leps (Thomas M.), Inc., Menlo Park, CA.
T. M. Leps.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 368-387, 10 fig, 1 tab, 53 ref.

Descriptors: *Rockfill dams, *Dam design, *Engineering geology, *Rock properties, *Heterogeneity, Soil mechanics, Dam foundations, Compaction, Construction methods, Safety.

Many researchers have gone to great lengths to try to make determination of the properties of rockfill conform to the procedures and concepts of soil mechanics, and to be comparably meaningful. The overwhelming fact remains that it is virtually impossible and impracticable to adapt most soil-mechanics-type tests, within credible limits, to testing and evaluating materials that characteristically contain asymmetric boulders from 8 in. (20 cm) to 36 in. (90 cm) in size. It seems obvious that the primary function of rockfill in embankment dams is to provide structural support for whatever type of impervious zone in the dam may be desired. Rockfill-dam design considerations include rockfill sources, physical properties of source rock, quarry/borrow constraints, gradation controls, zoning of classes of rockfill within a dam, dirty rockfill, oversize rockfill, transportation and placement, foundation requirements, lift (layer) thickness and characteristics, compaction, slope stability, drainage, phased construction, quality control, and instrumentation. Three examples of advanced rockfill-dam design are given. Despite its extremely heterogeneous nature, rockfill offers the designer a construction material that, when placed with only the simplest of controls and good judgment, is strong, reliable, enduring, forgiving, and remarkably safe. (See also W89-05687) (Shidler-PTT)
W89-05712

ROCKFILL DAM CONSTRUCTION AND FOUNDATION TREATMENT,
Leps (Thomas M.), Inc., Menlo Park, CA.
T. M. Leps.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 388-408, 32 fig, 12 ref.

Descriptors: *Rockfill dams, *Dam construction, *Dam foundations, *Engineering geology, *Construction methods, Rock testing, Performance evaluation, Rock excavation, Construction materials, Construction equipment, Leakage.

Construction of rockfill requires judicious investigations, geological examination, and engineering assessment of the source rock; but beyond that it is a job for massive, rugged equipment and simple, sensible procedures, emphasizing strong organization and reliance on visual observations and sound judgment. Except for the essential need for strength testing of 'representative' samples in the laboratory, little can be done of a theoretical or laboratory nature to realistically evaluate the performance characteristics of rockfill. Historically there have been five major sources of rockfill: quarries; tunnel muck; alluvial deposits of boulders, cobbles, and gravels; talus slopes; and dredger tailings. Rockfill processing, a term that may generally be limited to cover screening to remove either excessively large rocks or an excess of fines, is likely to be expensive and hence usually unattractive. Rockfill is generally transported by very large, powerful, off-highway, rubber-tired trucks or bottom-dump wagons, and rarely by conveyor belt. The foundation material on which rockfill is placed should provide safe structural support of the rockfill, and should not be damaged by whatever leakage may occur through the impervious element or its foundation. A group of 32 photographs is included to illustrate particularly important, on-the-job construction conditions at a number of projects. (See also W89-05687) (Shidler-PTT)
W89-05713

ROCKFILL DAM PERFORMANCE AND REMEDIAL MEASURES,
Leps (Thomas M.), Inc., Menlo Park, CA.
For primary bibliographic entry see Field 8A.
W89-05714

8E. Rock Mechanics and Geology

SPECIALIZED INVESTIGATION TECHNIQUES FOR DEFINING KARSTIC CAVITIES,
Golder Associates, Mississauga (Ontario).
For primary bibliographic entry see Field 7B.
W89-04603

LOW SLUMP COMPACTION GROUTING FOR CORRECTION OF CENTRAL FLORIDA SINKHOLES,
GKN Hayward Baker, Inc., Tampa, FL.
For primary bibliographic entry see Field 4B.
W89-04604

CASE STUDY: REMEDIATION OF KARST COLLAPSES IN WATER/WASTEWATER IMPOUNDMENTS,
Syntex Agribusiness, Inc., Springfield, MO.
For primary bibliographic entry see Field 5G.
W89-04605

INTERLACHEN, FLORIDA; A DESCRIPTION OF THICKLY MANTLED KARST,
GeoLogic Information Systems, Gainesville, FL.
For primary bibliographic entry see Field 2F.
W89-04610

ASSESSMENT BY ELECTRICAL RESISTIVITY METHODS OF POTENTIAL GEOLOGICAL HAZARDS IN KARSTIC TERRANES,
Florida Univ., Gainesville. Dept. of Geology.
D. L. Smith, and A. F. Randazzo.
IN: Proceedings of the Environmental Problems in Karst Terranes and Their Solutions Conference. National Water Well Association, Dublin, OH. 1986. p 487-501, 9 fig, 16 ref.

Descriptors: *Karst, *Subsidence *Groundwater *Resistivity, *Geological surveys, *Geophysics, *Florida, Conductivity, Limestone, Electrical studies.

Collapse or subsidence over subsurface dissolution cavities poses a significant jeopardy for structures in the karstic terrane of north-central Florida. Major construction projects are often preceded by extensive exploratory boring efforts to develop an appraisal of potential sinkhole activity. Analyses of direct current electrical resistivity anomalies can also yield a reliable assessment of the presence and magnitude of subsurface cavities. In an otherwise geoelectrically uniform medium of limestone, cavities below the water table are anomalous because the ion-rich groundwater is more conductive than the water-saturated country rock. Air-filled cavities have an infinite resistance and display a positive resistivity anomaly. Using an appropriate combination of sounding and profiling methods with the Wenner electrode configuration, cavities of can be detected to depths of 50-70 ft. Based on borehole confirmations, a direct relationship between electrode spacing and effective depth of current penetration appears to exist in Florida limestones. While standard Wenner electrode arrays can be used to detect cavities and to estimate their depth, the pole-dipole resistivity method is used to determine the probable size and configuration of the

subsurface feature. A specially-adapted geophysical interpretation technique using intersecting pairs of arcs has been shown to depict the shape and position of electrically anomalous features accurately below the surface. Pre-construction surveys of selected land parcels for potentially hazardous, near-surface cavities can be accomplished more economically and with less disruption by electrical resistivity surveys than by borehole drilling. (See also W89-04586) (Author's abstract)
W89-04612

SINKHOLES IN FLORIDA: AN INTRODUCTION,
Florida Sinkhole Research Inst., Orlando.
For primary bibliographic entry see Field 2F.
W89-04620

GEOLOGY FOR PLANNING IN BOONE AND WINNEBAGO COUNTIES,
Illinois State Geological Survey Div., Champaign.
For primary bibliographic entry see Field 2F.
W89-04626

GEOLOGY FOR PLANNING IN BOONE AND WINNEBAGO COUNTIES.
Illinois State Geological Survey Div., Champaign. Illinois State Geological Survey Division, (No date). 3 plates.

Descriptors: *Boone County, *Winnebaga County, *Soil disposal fields, *Illinois, *Waste disposal, *Geologic mapping, *Maps, Geologic formations, Land disposal, Classification, Data collections, Soil properties, Soil adsorption capacity, Septic tanks.

Three plates are combined under one title. They are individually titled: (1) Geologic materials to a depth of 20 ft in Boone and Winnebago Counties; (2) Classification of geologic materials for land burial of wastes in Boone and Winnebago Counties; and (3) Classification of geologic materials for waste disposal by septic tank soil absorption systems in Boone and Winnebago Counties. (Lantz-PTT)
W89-04641

BEDROCK TOPOGRAPHY AND GLACIAL DEPOSITS OF THE COLONIE CHANNEL BETWEEN SARATOGA LAKE AND COEYMANS, NEW YORK WITH A SECTION ON THE GROUND-WATER POTENTIAL OF THE CAPITAL DISTRICT BURIED-VALLEY DEPOSITS,
Geological Survey, Albany, NY. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-04835

BEDROCK TOPOGRAPHY AND GLACIAL DEPOSITS OF THE COLONIE CHANNEL BETWEEN SARATOGA LAKE AND COEYMANS, NEW YORK,
New York State Geological Survey/State Museum, Albany.
For primary bibliographic entry see Field 2F.
W89-04836

GEOLOGY OF THE SURFICIAL AQUIFER SYSTEM, DADE COUNTY, FLORIDA,
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-04925

RECONNAISSANCE OF SURFICIAL GEOLOGY, REGOLITH THICKNESS, AND CONFIGURATION OF THE BEDROCK SURFACE IN BEAR CREEK AND UNION VALLEYS, NEAR OAK RIDGE, TENNESSEE,
Geological Survey, Nashville, TN. Water Resources Div.
A. B. Hoos, and Z. C. Bailey.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4165. 1986. 9p, 2 fig, 2 tab, 16 ref, 1 plate in pocket.

Descriptors: *Geologic data, *Geology, *Bedrock, *Topography, *Oak Ridge, *Geophysics, Drillers logs, Maps, Boreholes, Weathering.

A preliminary interpretation of the lithology, thickness of regolith, and configuration of the bedrock surface underlying Bear Creek and Union Valleys near Oak Ridge, Tennessee, was made based on geologic and geophysical data from boreholes and cores in Bear Creek Valley and on related work of other investigators. Analysis of drillers' logs and lithologic logs and comparison of these data with a topographic map indicated that topography and depth of weathering are interdependent and are ultimately controlled by lithology. Topographic patterns were, therefore, used to extend localized geologic data to a larger scale. Maps of the surficial geology, thickness of regolith, and configuration of the bedrock surface are presented. (Author's abstract)
W89-04937

ADVANCED DAM ENGINEERING FOR DESIGN, CONSTRUCTION, AND REHABILITATION.
For primary bibliographic entry see Field 8A.
W89-05687

LESSONS FROM NOTABLE EVENTS: THE BALDWIN HILLS RESERVOIR FAILURE,
Leps (Thomas M.), Inc., Menlo Park, CA.
T. M. Leps, and R. B. Jansen.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 8-16,58, 5 fig, 4 ref.

Descriptors: *Baldwin Hills Dam, *California, *Dam failure, *Reservoirs, *Engineering geology, *Reservoir design, *Geologic fractures, Subsidence, Erosion, Oil fields, Drains, Soil types, Reservoir linings, Seismic properties.

In 1963 water broke violently through the downstream face of Baldwin Hills Dam in Los Angeles, California. The Inglewood Fault, the most northerly of four principal faults of the Newport-Inglewood uplift, is about 500 ft west of the reservoir. Three minor, steeply dipping faults, designated Faults I, II, and V, pass through the reservoir, angling away from the Inglewood Fault. The reservoir and its immediate environs were subjected to many adverse forces, including horizontal and vertical displacement due to subsidence; local breaking of the weak foundation; some erosion at the faults; and rebound effects due to oil-field repressurization, reservoir loading and unloading in 1951 and 1957, and the final inrush of water into the Fault I-II zone at time of failure. Facing the same site conditions now, and armed with the knowledge of what went wrong at Baldwin Hills, designers could make several improvements. The obvious first step would be to avoid rigid drains close to the water face and to the unstable and erodible foundation. A paved earth lining similar to that in the original design would be acceptable, but preferably of soils with higher plasticity. An impermeable, reinforced, multi-ply synthetic membrane, placed on a well-prepared subgrade, might provide an effective underseal. The designers of any facility at the site also would have to be mindful of the seismic potential of the area. (See also W89-05687) (Shidler-PTT)
W89-05688

LESSONS FROM NOTABLE EVENTS: THE FAILURE OF MALPASSET DAM,
For primary bibliographic entry see Field 8A.
W89-05689

LESSONS FROM NOTABLE EVENTS: THE ST. FRANCIS DAM FAILURE,
R. B. Jansen.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 28-34,59, 4 fig, 6 ref.

Descriptors: *California, *St. Francis Dam, *Dam failure, *Dam foundations, *Geologic formations, Landslides, Concrete construction, Conglomerate rocks, Clays, Wetting, Cohesion, Engineering geology, Grouting, Inspection.

St. Francis Dam, California, a key facility of the Los Angeles Bureau of Water Works and Supply system, collapsed in March 1928. The dam had no inspection gallery, and the foundation was not pressure-grouted. The canyon floor and the left abutment were composed of a relatively uniform mica schist with pronounced thin laminations, while the right abutment was a red conglomerate that has been described as poorly-assorted schist, granite, and sandstone detritus. Some investigators conjectured that the failure may have been caused by a massive landslide on the left abutment. The dam was built against schist in which the thin laminations stood nearly parallel with the slope of the canyon wall. The concrete was poured against the smooth cleavage faces of the schist and adhered to them, but there was little adherence between the schist laminations themselves. Evidently, the particles of the conglomerate were held together merely by the films of clay and when the mass is wet all cohesion is lost. Lessons have been learned from the St. Francis Dam failure. Site exploration must include a search for old or potential slides and an evaluation of their possible effects on the dam. Consideration must be given to foundation capability under a full range of foreseeable conditions, including shearing and weakening due to wetting. The need for foundation grouting has to be carefully assessed. (See also W89-05687) (Shidler-PTT)
W89-05690

LESSONS FROM NOTABLE EVENTS: FAILURE OF TETON DAM,
Leps (Thomas M.), Inc., Menlo Park, CA.
T. M. Leps.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 34-41,59, 4 fig, 3 ref.

Descriptors: *Teton Dam, *Idaho, *Dam failure, *Earth dams, *Geology, *Dam design, *Seepage, Geomorphology, Geologic joints, Aeolian deposits, Hydraulic fracturing, Compaction.

Teton Dam failed in 1976 during first filling of the reservoir. The dam was located in a steep-walled canyon incised into a volcanic-origin plateau draining into the Snake River Plain, Idaho. It was a compacted, central-core, zoned, earth and gravel fill embankment. The fundamental cause of failure may be regarded as a combination of geological factors and design decisions that, taken together, permitted failure to develop. The principal geologic factors were (1) the numerous open joints in the abutment rocks, and (2) the scarcity of more-suitable materials for the impervious zone of the dam than highly-erodible and brittle windblown soils. The design decisions included among others (1) complete dependence for seepage control on a combination of deep key trenches filled with windblown soils and a grout curtain; (2) selection of a geometrical configuration for the key trench that encouraged arching, cracking, and hydraulic fracturing in the brittle and erodible backfill; (3) reliance on special compaction of the impervious materials as the only protection against piping and erosion of the material along and into the open joints, except some of the widest joints on the face of the abutments where concrete infilling was used; and (4) inadequate provisions for collection and safe discharge of seepage which inevitably would occur through the foundation rock and cutoff systems. (See also W89-05687) (Shidler-PTT)
W89-05691

LESSONS FROM NOTABLE EVENTS: VAIONT RESERVOIR DISASTER,
Kiersch Associates, Inc., Tucson, AZ.
G. A. Kiersch.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 41-53,59, 10 fig, 19 ref.

Descriptors: *Vaiont Dam, *Italy, *Dam failure, *Slope stability, *Landslides, *Disasters, *Geolog-

ic formations, Geologic units, Geological surveys, Stress, Strength, Animal behavior.

One of the worst dam disasters in history, claiming more than 2000 lives, occurred in 1963 at the Vaiont Dam in Italy. This tragedy, caused by a tremendous landslide, is a benchmark case both for inadequate regional/areal geological investigations and for a misconception of site-specific geological features. The disaster involved one of the world's highest dams (267 m), which sustained no damage to the main shell or abutments. Sudden tremendous slope failure caused an overtopping of the dam by a wave some 125 m high. The following adverse features of the geologic environs and reservoir area helped cause the catastrophic landslide: (1) Steeply tilted rock units and an abundance of bedding slips, clay interbeds, partings, and numerous old slide planes and faults. (2) The steep dip of beds changes northward to Vaiont canyon, where rock units abruptly flatten along a synclinal axis. (3) An ancient slide plane occurred throughout the reservoir wall and extended upslope through the area of sliding. (4) Numerous geological features enhanced and facilitated the gravitational sliding as stresses increased and strength decreased. Interestingly, some ten days before collapse, the animals grazing on slopes became nervous and moved off the area of subsequent sliding, suggesting a unique detection technique for evaluating the stability of a slope. (See also W89-05687) (Shidler-PTT)
W89-05692

LESSONS FROM NOTABLE EVENTS: THE WALTER BOULDIN DAM FAILURE,
Lepš (Thomas M.), Inc., Menlo Park, CA.
For primary bibliographic entry see Field 8A.
W89-05693

GEOLOGY: GEOLOGICAL CONSIDERATIONS; REGIONAL-AREAL GEOSCIENCE INVESTIGATIONS,
Kiersch Associates, Inc., Tucson, AZ.
G. A. Kiersch.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 106-117, 149-150, 6 fig, 17 ref.

Descriptors: *Engineering geology, *Geological surveys, *Areal hydrogeology, *Geologic mapping, *Dam stability, Geologic units, Data collections, Damsites, Reservoirs, Site selection, Risks, Excavation, Deterioration.

The performance histories of dams and appurtenant works demonstrate that no structure is entirely free from risks of progressive deterioration or destruction. The importance of regional/areal investigations for obtaining critical geosciences data is frequently overlooked. Many geological situations initially require the creative, fragmentary evidence approach, with the remaining parts of the puzzle available only after subsurface excavation or laboratory tests. This first appraisal invariably discloses some inherent problems, which are fundamental to the geological origin of the rock units, structural features, erosional features, and weathered or surficial deposits. Selecting a dam or hydro-power plant site requires balancing many conflicting values that may not be measurable on a common scale, except in the broadest sense--that of the public interest. The most successful method of utilizing regional/areal investigations is the 'convergence-of-evidence' approach, whether for mapping an uncharted sector or for a comprehensive analysis of an individual preferred dam site. Significant data collected at a distance from the site can be utilized to advantage in evaluating conditions within a specific site. Many cases citing the importance of regional/areal geological features to dam and reservoir planning/design/construction/operation are available in the literature. (See also W89-05687) (Shidler-PTT)
W89-05695

GEOLOGY: SEISMOTECTONIC INVESTIGATIONS,
A. L. O'Neill.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 117-124,150-151, 1 fig, 27 ref.

Descriptors: *Damsite selection, *Engineering geology, *Seismic properties, *Tectonics, *Earthquake engineering, *Geological surveys, Damsites, Dams, Dam foundations, Geologic fractures, Deformation, Earthquakes, Reservoirs.

Thorough geotechnical investigations for dam and reservoir projects have almost always included some consideration of seismicity and faulting. Damage can occur to dams from earthquake shaking effects and/or from displacements along faults in the foundation or vicinity. The tectonic setting and the seismicity and history of faulting govern the extent and method of earthquake analysis appropriate for a dam at any particular site. Determination of the full range of earthquake parameters for design purposes requires a team that includes geologists, seismologists, engineers, and often other technical specialists. Fault investigations for dam studies continue to be an evolving technology subject to new scientific developments and considerable judgement. Every dam site does not require the same level of fault investigation; a well planned and executed geologic investigation for most dam sites will provide the data required for the seismic assessment and will identify those sites wherein more extensive seismotectonic investigations are required. The various levels of investigation required depend on the relationship of the faulting systems to the dam site and on the criticality of seismic motion and deformation to the dam. Experienced investigators can determine the appropriate level of studies for the more comprehensive investigations. (See also W89-05687) (Shidler-PTT)
W89-05696

GEOLOGY: LAND SUBSIDENCE,
L. B. James.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 124-133,151, 9 fig, 37 ref.

Descriptors: *Damsite studies, *Engineering geology, *Subsidence, *Rock mechanics, *Soil mechanics, *Dam failure, Collapse, Craters, Groundwater, Wetting, Soil density, Peat soils, Deformation, Tectonics.

Although only a few dam failures have been attributed to subsidence, many other structures have been seriously damaged by it. A brief review of five causes of subsidence is presented. Land subsidence and consequent failure of facilities and structures may result from (1) withdrawal of fluids from the earth; (2) hydrocompaction, that is, the failure of certain low-density soils upon wetting; (3) collapse or deformation of subsurface cavities; (4) consolidation of organic soils; and (5) tectonic warping of the earth's crust. Regions that overlie porous, sedimentary deposits containing groundwater, petroleum, or geothermal fluids may experience varying degrees of subsidence when these fluids are exploited. The structure of certain low-density soils collapses upon application of water, causing a type of subsidence known variously as hydrocompaction, 'shallow subsidence', or hydroconsolidation. Collapses of underground cavities are reflected on the surface as depressions, pits, or craters; cavities are classified as natural, induced, or mined, according to mode of origin. Histosols, commonly called peat or muck, have been associated with subsidence at engineering projects for many centuries. Surface deformation due to tectonic activity, often of regional dimensions, is caused by stresses from movements of the earth's crustal plates. (See also W89-05687) (Shidler-PTT)
W89-05697

GEOLOGY: FOUNDATION DEFECTS,
Bechtel Civil and Minerals, Inc., San Francisco, CA.
A. B. Arnold.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 134-149,151-152, 19 fig, 16 ref.

Descriptors: *Engineering geology, *Dam foundations, *Seepage, Stability, *Damsites, *Geologic fractures, *Geologic joints, Dam construction, Abutments, Embankments, Seismic properties, Pipe flow.

Dams should be located on a competent foundation in a geologically and seismologically stable area. The major cause of most dam foundation problems is seepage, which can contribute to abutment sliding, embankment failures, and piping of the foundation. A case history involving seepage is the Colstrip Surge Pond Dam (California). Faults at damsites are usually at least suspected during the preliminary geological investigation of the site; however, vegetation and deposits of alluvium, colluvium, and so on, may cover the area so that their presence and/or significance is not understood until they are uncovered during the final phase of exploration or during construction. Cedar Springs Dam (California) is an example of a construction site with fault problems. Joints in the abutments of dams often lead to slope stability problems, and joints under a dam can provide avenues for seepage that could contribute to piping or foundation erosion. A dam which failed because of joint problems was Teton Dam (Idaho). Stress relief in 'soft' rocks usually occurs as rebound of the foundation; differential rebound can cause serious foundation problems. Such problems were encountered at Oahe Dam (South Dakota). Most foundation cavities or solution features that permit seepage through a dam foundation are a result of dissolving of limestone. Solution cavity problems were encountered at Kentucky Dam (Kentucky), among others. (See also W89-05687) (Shidler-PTT)
W89-05698

SEISMOLOGY,
California Univ., Berkeley. Seismographic Station.
B. A. Bolt.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 153-171, 6 fig, 1 tab, 34 ref.

Descriptors: *Geology, *Damsite studies, *Dam failure, *Seismology, *Earthquakes, *Earthquake engineering, *Engineering geology, Reservoirs, Dam design, Soil engineering, Seismic waves, Seiches, Landslides, Case studies.

A number of examples could be cited of major structural damage to dams by 'regular' earthquakes. In addition to the danger from regular earthquakes, several examples of damaging earthquakes apparently related in some way to reservoir loading behind the dam have now occurred. Inputs to the design of dam structures should include the near field of earthquake sources, mathematical seismic source models, and types of waves near to the seismic source. Geological input, seismological input, and soils engineering input must be considered in assessment of seismic risk of a site. Examples of factors influencing estimation of strong ground-motion parameters are duration of shaking, effective peak acceleration, time-history synthetics, attenuation of ground accelerations, and variability of parameters. Water waves (seiches) may be generated by a sudden fall of rock and soil into a reservoir or lake; such avalanches may be spontaneous, as, for example, the slide that caused overtopping of the Vaiont Dam and downstream deaths in Italy in 1963, or they may be triggered by a large earthquake. Strong-motion instrumentation, local seismograph networks, and utilization of records obtained during earthquakes are recommended. Oroville Dam, California; Aswan High Dam, Egypt; the San Fernando Earthquake, February 9, 1971; and Hsinfenkiang Dam, China; are used as illustrative case studies. (See also W89-05687) (Shidler-PTT)
W89-05699

MATERIALS: MATERIALS FOR EMBANKMENTS,
For primary bibliographic entry see Field 8D.
W89-05700

EARTHQUAKE RESPONSE ANALYSIS OF EMBANKMENT DAMS,
Woodward-Clyde Consultants, Oakland, CA.
I. M. Idriss, and J. M. Duncan.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 239-255, 14 fig, 3 tab, 47 ref.

Descriptors: *Earthquakes, *Earthquake engineering, *Earth dams, *Embankments, *Dam stability, Seismic properties, Soil dynamics, Cohesionless soils, Finite element method, Soil tests, Shear stress, Dam foundations.

Observations of the behavior of earth dams in past earthquakes have highlighted the value of seismic-stability evaluations in assessing the overall performance of an earth dam in a seismic area. Dynamic analyses provide better indications of the behavior of such dams under earthquake-loading conditions. However, pseudostatic analysis procedures offer a simple and reasonable means for evaluating the potential behavior of embankments built of clay soils, or those constructed of very dense cohesionless soils with little likelihood of major decreases in undrained shear strength due to anticipated levels of shaking. The response of the system to the applied base-rock motion is most conveniently obtained by using a dynamic finite-element procedure. Cyclic strength characteristics are generally determined by an appropriate laboratory testing program on either reconstituted samples or high-quality undisturbed samples. The seismic stability of an earth dam is evaluated by comparing the calculated equivalent uniform cyclic shear stresses induced by the earthquake with the cyclic shear-strength characteristics, to determine the potential strains in the embankment and foundation. The analytical procedures (including appropriate use of the pseudostatic method of analysis when applicable) outlined provide a guide to assessing the probable performance of earth dams under earthquake loading conditions. (See also W89-05687) (Shidler-PTT)
W89-05708

EARTHFILL DAM DESIGN AND ANALYSIS,
For primary bibliographic entry see Field 8A.
W89-05709

EARTHFILL DAM CONSTRUCTION AND FOUNDATION TREATMENT,
For primary bibliographic entry see Field 8D.
W89-05710

ROCKFILL DAM DESIGN AND ANALYSIS,
Leps (Thomas M.), Inc., Menlo Park, CA.
For primary bibliographic entry see Field 8D.
W89-05712

ROCKFILL DAM CONSTRUCTION AND FOUNDATION TREATMENT,
Leps (Thomas M.), Inc., Menlo Park, CA.
For primary bibliographic entry see Field 8D.
W89-05713

EARTHQUAKE RESPONSE ANALYSIS OF CONCRETE DAMS,
California Univ., Berkeley. Dept. of Chemical Engineering.
A. K. Chopra.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 416-465, 44 fig, 8 tab, 47 ref.

Descriptors: *Earthquake engineering, *Structural behavior, *Concrete dams, *Gravity dams, *Arch dams, *Dam design, Cracking, Safety, Reservoirs, Dam foundations, Design criteria.

The prediction of the performance of concrete dams during earthquakes is one of the more complex and challenging problems in structural dynamics. The limitations of traditional design procedures are identified, the significance of interaction effects and other factors that should be considered in dynamic analysis is discussed, and procedures for simplified response-spectrum analysis and refined response-history analysis are presented for gravity dams and arch dams. The application of simplified and refined linear-analysis procedures in the earthquake-resistant design of new dams and in the seismic-safety evaluations of existing dams is discussed, and some of the limitations of presently-available nonlinear analysis procedures in predicting the extent of cracking and damage that a concrete dam may experience during very intense ground shaking are identified. Dynamic-analysis procedures should consider the following factors: dam/water interaction, reservoir-boundary absorption, water compressibility, and dam/foundation rock interaction. In order to produce safe and economical designs for concrete dams, the most reliable techniques considering these factors should be used to evaluate proposed designs for new dams; furthermore, the reliability of present design methods should be improved. There is considerable interest in reevaluating original dam designs using current procedures. (See also W89-05687) (Shidler-PTT)
W89-05715

8F. Concrete

MATERIALS: CONVENTIONAL CONCRETE FOR DAMS,
R. B. Jansen.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 193-197,218, 1 tab, 4 ref.

Descriptors: *Construction materials, *Dam construction, *Concrete dams, *Concrete mixes, *Concrete technology, Construction methods, Cements, Mass concrete, Pozzolans, Concrete additives, Temperature control, Curing, Durability, Elastic properties, Strength.

Conventional-concrete constituents, properties, and behavior and concrete-construction methods are described. Concrete is a mixture of cement, water, and rock and/or sand aggregates. It may also contain pozzolans and/or other admixtures. Cements that have been used in mass concrete for dams include portland cement, blended cement, natural cement, and slag cement. Water for making concrete should be free of substances that would adversely affect production, placement, or curing. Pozzolans are siliceous or siliceous and aluminous substances that may have minimal cementing value intrinsically, but react chemically with calcium hydroxide to form cementitious compounds. Accelerators, air-entraining agents, and water-reducing, set-controlling admixtures are used in mass concrete to increase workability, reduce the water/cement ratio, accelerate or retard setting, accelerate gain in strength, and improve durability. Temperature control and curing are discussed. The precooling of concrete materials before mixing reduces temperature differentials by lowering the set temperature of the mass, prior to heat generation. Concrete improves with age if moisture is retained so that conditions are conducive to continuing hydration of the cement. The durability, modulus of elasticity, Poisson's ratio, creep, thermal properties, tensile strength, and shear strength of concrete also describe attributes of concrete. These parameters are described and representative values given for American dams. (See also W89-05687) (Shidler-PTT)
W89-05703

MATERIALS: SPECIAL CONCRETES,
E. K. Schrader.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 198-201,218, 11 ref.

Descriptors: *Construction materials, *Concrete technology, *Reinforced concrete, *Concrete mixes, *Dam construction, Cavitation, Erosion, Silica, Stilling basins, Spillway crests, Slope stabilization, Polymers, Portland cements.

Fiber-reinforced concrete, silica fume, shotcrete, and polymers and latex in concrete are discussed. Fiber reinforcement incorporates individual wire-like elements throughout the concrete mix; the properties of fiber-reinforced concrete make it very desirable in areas where cavitation damage and/or erosion by large debris at high velocity is likely. Silica fume, sometimes called micro silica, is composed of silicon dioxide particles less than 1 micron in size; added to concrete, silica fume results in a very high strength and a hard surface. Shotcrete, or pneumatically-placed mortar and concrete, is used frequently in dam construction for purposes ranging from stilling-basin repairs to embedding gate guides, to construction of spillway crests, to rockslope stabilization. Polymers are used in concrete for a variety of reasons and in a variety of ways. Polymer impregnation is a technique used to modify existing concrete by impregnating it with liquid monomer that is then polymerized in place. Polymer concrete is a mixture of graded aggregates and monomer; normally there is sufficient monomer in the system for it to react and fully polymerize itself within about 20 minutes of being mixed. Polymer portland-cement concrete, or latex-modified concrete, has been used in repairs and to provide a relatively-thin bonded overlay when necessary on the top of a dam. (See also W89-05687) (Shidler-PTT)
W89-05704

MATERIALS: MATERIALS AND MIXTURE PROPORTIONING CONCEPTS FOR ROLLER COMPACTED CONCRETE DAMS,
Bureau of Reclamation, Denver, CO.
T. P. Dolen.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 202-213,218, 8 fig, 1 tab, 5 ref.

Descriptors: *Concrete technology, *Dam construction, *Construction materials, *Concrete mixes, *Concrete dams, *Roller-compacted concrete, Mass concrete, Bonding, Cracks, Aggregates, Cements, Pozzolans, Compressive strength, Soil compaction, Materials testing.

The concepts of RCC (roller-compacted concrete) and RCC-mix design philosophies have evolved from two technologies: that of a 'stabilized fill' and the traditional mass-concrete dam technology. An RCC-mix design must achieve two conflicting requirements: (1) provide sufficient paste volume to assure bond (cohesion) between lifts (concrete layers), and (2) minimize the paste volume to reduce the thermal cracking potential. Materials used for RCC consist of water, cementitious materials, fine and coarse aggregate, and admixtures. Aggregates used for RCC consist of both fine (passing a 4.75-mm sieve) and coarse fractions. Cementitious materials used in RCC dams consist of cement plus pozzolan. Mix design methods have varied considerably for RCC structures throughout the world. Proportioning for optimum workability suitable for compaction at specific design strengths has been used as the basis of the construction method for dams in Japan and the United States. A number of lean RCC mixes have been proportioned using a relatively fixed grading of aggregates while varying cementitious materials and water content to meet the required compressive strength. Other proportioning methods have evaluated RCC using soil-compaction procedures. Evaluation and testing of RCC mixes should be performed for the mix design study, during construction, and if possible, following construction. (See also W89-05687) (Shidler-PTT)
W89-05705

MATERIALS: COMPARATIVE LIMITS AND ADVANTAGES OF RCC,
E. K. Schrader.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 213-215,218, 1 fig, 3 ref.

Descriptors: *Concrete technology, *Construction materials, *Roller-compacted concrete, *Dam construction, Concrete mixes, Aggregates, Cements,

Pozzolans, Concrete additives, Construction methods, Materials testing.

Roller-compacted concrete (RCC) can be made from materials suitable for conventional concrete, but many marginal materials, and some materials unacceptable by normal standards for conventional concrete, can produce very suitable RCC for dam construction. If an RCC section is overbuilt for ease of construction or as part of the design, it probably can perform quite satisfactorily with a lower unit weight than is typically experienced; consequently the required specific gravity for the aggregate can be reduced, and materials such as shale or marlstone (which has been used in RCC) become acceptable. Cement and pozzolan used in RCC generally must meet the same requirements as for conventional concrete, except that--as with the aggregates--some provision usually can be made for marginal materials. Chemical admixtures do not effectively, reliably, and consistently work in mass RCC mixes. The fresh RCC is delivered by scraper, dump truck, or conveyor; spread with a dozer; and compacted with a vibratory roller. Basic tests of aggregate, cement, pozzolan, and water to be used in RCC follow the same standard procedures used for conventional concrete, although some acceptance criteria may be modified. The best method of RCC-mix evaluation is to cast slabs or blocks with several RCC layers using high-energy compaction equipment that simulates field conditions. (See also W89-05687) (Shidler-PTT)
W89-05706

CONCRETE DAM CONSTRUCTION AND FOUNDATION TREATMENT,
For primary bibliographic entry see Field 8A.
W89-05718

CONCRETE DAM PERFORMANCE AND REMEDIAL MEASURES,
For primary bibliographic entry see Field 8A.
W89-05719

SPILLWAY DESIGN AND CONSTRUCTION: CONSTRUCTION CONSIDERATIONS,
For primary bibliographic entry see Field 8A.
W89-05730

8G. Materials

LOADING POINT PUNCTURABILITY ANALYSIS OF GEOSYNTHETIC LINER MATERIALS,
Southwest Research Inst., San Antonio, TX.
D. L. Laine, M. P. Miklas, and C. H. Parr.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-235544. Price codes: A06 in paper copy, A01 in microfiche. Report No. EPA/600/2-88/040, March 1988. 104p, 38 fig, 12 tab, 11 charts, 44 ref, 5 append. EPA Contract 68-03-3231. SWRI Project 14-8294.

Descriptors: *Geomembranes, *Liners, *Materials testing, Polymers, Polyvinyl chloride, Chlorosulfonated polyethylene, Polyethylene, Temperature, Pressure, Particle size.

Geomembrane liner performance in laboratory tests designed to subject several different liner materials to varying pressures, temperatures, and point loads. Preliminary tests resulted in the selection of a cast epoxy resin cone having a 35-degree apex angle and truncated 2.8 mm from the apex at 45-degrees to the cone axis. Polyvinyl chloride (PVC), chlorosulfonated polyethylene (CSPE), and high density polyethylene (HDPE) materials, in two thicknesses each, were subjected to a constant hydrostatic load of 17.93 kPa at 23 C and 50 C over a 365-day period. HDPE material measuring 1.5 mm thick failed for the loading point height of 25.4 mm above the subgrade. After 365 days, the loading pressure was increased to 60.03 kPa for an additional 30 days. Failures were induced in 1.5 mm HDPE for loading point heights of 19.0 and 25.4 mm and in 2.5 mm HDPE for loading point heights of 25.4 mm. Nonwoven geotextile fabric material of 1.5, 3.8, and 5.3 mm was placed between the liner and the loading points and selected tests were run. HDPE with a thickness of 1.5 mm failed for a loading point height of 19.0 mm with a 1.5 mm geotextile placed between the HDPE and the loading point. These tests were conducted at 17.94 kPa pressure and ambient temperature. HDPE with a thickness of 2.5 mm overlaying a 3.8 mm geotextile failed under 60.03 kPa pressure for a 25.4 mm loading height at the high temperature test condition. No materials failed when overlaid upon a 5.3 mm geotextile for any of the test temperatures or loading heights. Transient pressure loading tests of the membrane material without geotextile support showed failures when the pressure rate of change exceeded 55.20 kPa per hour. The maximum pressure load on the membrane proved to be the failure stress factor rather than the rate at which pressure was applied. The test results indicate that moderate economic benefit may be gained by allowing larger particles than current engineering practice deems acceptable to remain in a subgrade surface. (Lantz-PTT)
W89-04850

LOCK AND DAM NO. 26 (REPLACEMENT) COFFERDAM EXPERIMENTAL AND ANALYTICAL STUDY. REPORT 5: TENSILE TESTS OF STEEL SHEET PILES,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Structures Lab.
E. F. O'Neil, and W. E. McDonald.
Available from the National Technical Information Service, Springfield, VA 22161. Technical Report ITLL-88-3, September 1988. Report 5 of a Series. 155p, 5 fig, 4 tab, 6 append.

Descriptors: *Sheet-steel Piling, *Construction joints, *Cofferdams, *Tensile strength, *Materials testing, Steel, Interlock joints, Dams, Regression analysis, Finite element method.

A comprehensive tensile testing and analysis program for steel sheet pile specimens was conducted to develop useful data characterizing the failure mechanism. Analysis of the behavior of individual sheet piles as well as sheet piles combined as a system are described. Particular attention was given to the interlock joints connecting the sheet pile specimens. A total of 10 sheet pile tensile tests were performed using steel material from two manufacturers. Five of the sheet pile specimens were of standard-strength steel and five were of high-strength steel. Extensive documentation of the tests included strain gages with XY plots, linear variable displacement transducer displacement readings, before and after tracings of the configurations of the sheet pile specimens as tested, photographic deformation histories, and video cassette recordings of the tests. Failure of each sheet pile specimen was a result of separation of the connecting interlock joints due to bending deformations. A regression analysis of the data was conducted to provide a best fit equation of the load versus deformation to provide input for a finite element code on sheet pile cofferdams being developed by the US Army Engineer Waterways Experiment Station and Virginia Polytechnic Institute. (Author's abstract)
W89-04857

CRITERIA FOR ACCEPTING PRECOATED AGGREGATES FOR SEAL COATS AND SURFACE TREATMENTS,
Pennsylvania Dept. of Transportation, Harrisburg. Office of Research and Special Studies.
P. S. Kandhal, and J. B. Motter.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-158126. Price codes: A04 in paper copy, A01 in microfiche. Final Report, August 1987. 68p, 21 fig, 17 tab, 15 ref, 4 append. Research Project 83-19.

Descriptors: *Road construction, *Highway construction, *Materials testing, *Aggregates, *Sealants, Adhesives, Binding.

One of the most common causes of seal coat failures is the presence of dust on the cover aggregate which prevents good adhesion between the applied bituminous binder and the aggregate. Precoating the aggregate with a very thin film of bituminous binder usually solves the dust problem and provides good adhesion. This research was undertaken: (a) to evaluate the adhesion of aggregates precoated to varying degrees so that the optimum precoating requirement can be established, and (b) to develop an end-result type test in lieu of the subjective visual test for accepting precoated aggregates. Five aggregates of different mineralogical compositions and absorptive characteristics were used. These aggregates were precoated with MC-30 Cutback asphalt to varying degrees (from salt and pepper effect to 90+ % coating). Pennsylvania Aggregate Retention Test developed in this study was used to evaluate the effect of precoating on aggregate retention loss. Immediate adhesion of the cover aggregate with the bituminous binder was best obtained at 90+ % precoating. The agreement (reproducibility) between different evaluators who made subjective visual evaluation of the percent precoating was also by far the best at 90+% level. Of the three end-result type tests attempted, dry gradation test of the precoated aggregate was most appropriate with an acceptance criteria of 0.5% maximum minus 200 (dust). (Author's abstract)
W89-04892

PREDICTING INTERNAL ROUGHNESS IN WATER MAINS,
Waterways Experiment Station, Vicksburg, MS.
W. W. Sharp, and T. M. Walski.
Journal of the American Water Works Association JAWWA5, Vol. 80, No. 11, p 34-40, November 1988. 4 fig, 4 tab.

Descriptors: *Water mains, *Pipes, *Hydraulic roughness, *Water conveyance, *Hydraulic engineering, Deterioration, Projections, Roughness coefficient, Mathematical equations, Data collections.

Some measurement of the internal roughness of pipes is an important parameter that enters into virtually all calculations involving the sizing and analysis of water distribution systems. The equations presented provide a quick method for predicting C-factors (internal roughness) in unlined metal pipes. The equations are based on the hypothesis that roughness height in such pipes grows approximately linearly over time and are verified with field data from numerous water distribution systems. The equations presented depend most heavily on a parameter, which describes the rate of growth of roughness over time and depends on the quality of the water with respect to corrosion or precipitation. This parameter should be determined from historical data for the given water system, or it can be estimated form the Langelier index or extrapolated from the data of other utilities with similar water quality. Because the C-factor is a logarithmic function of time, it tends to decrease most rapidly for new or recently cleaned pipes. After a few decades, however, the drop in C-factor over time is slow. (VerNooy-PTT)
W89-05245

IMPROVED METHOD FOR CORROSION-RATE MEASUREMENT BY WEIGHT LOSS,
North Carolina Univ. at Charlotte. Dept. of Civil Engineering.
S. Reiber, J. F. Ferguson, and M. M. Benjamin.
Journal of the American Water Works Association JAWWA5, Vol. 80, No. 11, p 41-46, November 1988. 5 fig, 3 tab, 8 ref.

Descriptors: *Corrosion, *Materials testing, *Testing procedures, Statistical analysis, Metals, Weight, Deterioration, Sampling, Precision.

A modified version of the American Society for Testing and Materials machined-nipple technique is presented. The simplified hardware is suitable for sampling large numbers of coupons simultaneously, providing a more accurate statistical analysis of corrosion variation and measurement precision. New coupon handling and retrieval procedures simplify test surface preparation and improve reproducibility. The reliability of the coupon preparation-restoration techniques and the subsequent reproducibility of weight-loss corrosion-rate measure expand the application range of this analysis

and make it simpler to develop an accurate picture of the corrosion process. Statistically meaningful corrosion-rate data can be achieved with as little as a two-week exposure period if a full 10-coupon sleeve is used. (VerNooy-PTT)
W89-05246

PREDICTING PIPELINE FROST LOAD,
Ontario Ministry of the Environment, Toronto.
For primary bibliographic entry see Field 2C.
W89-05249

MATERIALS: GEOSYNTHETICS IN DAM CONSTRUCTION,
Bureau of Reclamation, Denver, CO. Applied Sciences Branch.
L. O. Timblin.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 183-193,217, 3 tab, 29 ref.

Descriptors: *Construction materials, *Dam construction, *Geosynthetics, *Fabrics, *Impervious membranes, Polymers, Elastomers, Filtration, Drainage, Earth dams, Linings, Barriers, Compaction, Design criteria, Materials testing.

Geosynthetics include synthetic fabrics referred to as 'geotextiles' and impermeable membranes called 'geomembranes'. A geotextile is a porous fabric made of synthetic fibers that are not subject to degradation when embedded in soil. They are presently manufactured from polyester, polypropylene, nylon, polyethylene, polyvinylchloride, and fiberglass. Geotextiles can be used in filtration, drainage, separation, and reinforcement applications in fill dams. Geomembranes are very low-permeability membrane liners and barriers used with any geotechnical-engineering-related material to control fluid migrations in man-made projects, structures, or systems. They are manufactured from a number of polymers, elastomers, and their blends or alloys. Applications of geomembranes in fill dams, as for any other structure, require that the dam body be conventionally-compacted. Other geosynthetics are stiff open nets called 'geogrids', and combinations of geotextiles, geomembranes, and geogrids called 'geocomposites'. In recent years, developments in both the geosynthetic-materials and engineering fields have resulted in increased acceptance of geosynthetics as valuable design and construction materials. With proper selection of materials, good design procedures, and a strong testing program, geosynthetics offer a valuable set of new materials for the advanced-dam engineer. (See also W89-05687) (Shidler-PTT)
W89-05702

INSTRUMENTATION,
J. D. Lytle, B. C. Murray, J. M. Raphael, D. L. Misterek, and L. R. Carpenter.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 751-776, 1 fig, 10 tab, 20 ref.

Descriptors: *Measuring instruments, *Network design, *Automation, *Design criteria, *Dam stability, Data evaluation, Safety, Earth dams, Concrete dams, Structural behavior, Manpower.

Basic design requirements for measurements and instruments are addressed: devices, installation procedures, monitoring (observation) techniques, schedules, automated data acquisition methodology, and data evaluation. Instrumentation systems that monitor continuing dam integrity to ensure dam safety are predicated on the design relationship of all project features. Fourteen major embankment dams were designed and built by the U.S. Bureau of Reclamation in the decade following the Teton Dam failure, all with substantial amounts of instrumentation. Instrumentation for concrete dams in the United States effectively started with the extensive array of instruments installed in the Stevenson Creek Arch Dam by the Engineering Foundation to record the actual behavior of this experimental arch dam and to aid in the development of new analytical methods. The Bureau of Reclamation has long recognized the importance of automating structural behavior instrumentation in many of the 300 dams under its jurisdiction. Such automation is becoming increasingly attractive for a variety of reasons, such as the lack of available skilled manpower, the increased reading frequency, the large numbers of instruments used, the need for 24-hour surveillance because of dam safety criteria, and the remote location and weather-caused inaccessibility of some dams. (See also W89-05687) (Shidler-PTT)
W89-05744

SURVEILLANCE,
Construction Engineering Research Lab. (Army), Champaign, IL.
L. A. Duscha, and R. B. Jansen.
IN: Advanced Dam Engineering for Design, Construction, and Rehabilitation. Van Nostrand Reinhold, New York, NY. 1988. p 777-797, 6 ref.

Descriptors: *Data acquisition, *Network design, *Dam stability, *Monitoring, Measuring instruments, Concrete dams, Earth dams, Rockfill dams, Inspection, Case studies, Data interpretation.

Design of a surveillance system should be directed by dam engineers who understand both the capabilities and the limitations of instrumentation, in relation to potential structural performance. The monitoring capability for concrete and masonry dams has reached an advanced state of sophistication; for determining dam deformations, the most useful techniques are those that facilitate rapid measurement. Monitoring of an embankment dam requires knowledge of how it adjusts to imposed conditions; since embankment materials generally have very inelastic properties, deformation is larger and longer in duration than that of concrete or masonry dams. Typical surveillance programs--concrete, earthfill, and rockfill dam monitoring systems--are described. A surveillance program developed by the Army Corps of Engineers that has served as a model and subsequently has been followed by a number of dam owners is presented as a specific organizational example; inspection and evaluation program procedures are summarized. Oahe Dam (South Dakota), Walter F. George Dam (Alabama/Georgia), and instrumentation use during emergencies at Dworshak Dam (Idaho), are used as specific surveillance examples. Basic considerations, records, inspection, analysis, surveillance during initial impoundment, surveillance of appurtenant facilities, and surveillance of the environs are also described. (See also W89-05687) (Shidler-PTT)
W89-05745

8I. Fisheries Engineering

WATER USE PLAN FOR AQUACULTURE IN THE VIRGIN ISLANDS,
College of the Virgin Islands, St. Croix. Agricultural Experiment Station.
For primary bibliographic entry see Field 3B.
W89-04668

BENEFITS OF INCREASED STREAMFLOW: THE CASE OF THE JOHN DAY RIVER STEELHEAD FISHERY,
Oregon State Univ., Corvallis. Dept. of Agricultural and Resource Economics.
For primary bibliographic entry see Field 6D.
W89-05054

SHELLFISH CULTIVATION AND FISHERY BEFORE AND AFTER A MAJOR FLOOD BARRIER CONSTRUCTION PROJECT IN THE SOUTHWESTERN NETHERLANDS,
Rijksinstituut voor Visserijonderzoek, Yerseke (Netherlands). Molluscan Shellfish Research Dept.
R. Dijkema.
Journal of Shellfish Research JSHRDA, Vol. 7, No. 2, p 241-252, October 1988. 11 ref, 6 fig.

Descriptors: *Shellfish farming, *Estuarine fisheries, *Aquaculture, *Mollusks, The Netherlands, Oysters, Mussels, Mytilus, Fish management, Sea walls.

After a disastrous flood in 1953, a law was passed to close the mouths of all estuaries but one in the Southwest of the Netherlands. The estuaries concerned were planned to become fresh water lakes. Existing bottom culture of the blue mussel (Mytilus edulis) and the European flat oyster (Ostrea edulis) as well as finfish and shrimp fisheries were to disappear from the area. After a change in national politics and intensive lobbying by nature conservation and fishery organizations, this plan was modified in such a way that a restricted tidal movement would remain possible in the main estuary, the Oosterschelde (Eastern Scheldt). Besides, good ecological conditions in another estuary already shut off from the sea, prompted the decision to conserve this area as a tideless marine lake. Although many of the existing shellfish cultivation plots had to be abandoned, new possibilities have become apparent, such as the emerging of a natural population of the European flat oyster in stagnant Lake Grevelingen. Besides, new chances for bottom cultivation of mussels and oysters have become apparent in places where tidal current velocities have been reduced. Limits to shellfish culture and fishery can be set by locally too low current velocities and by food limitation due to competition or a reduced import of suspended matter from the North Sea. Phytoplankton production might also become limited as a result of reduced import of nutrients by rivers. Research is under way to assess new possibilities for aquaculture to predict possible effects of the project on environment and mariculture in the area. Management of aquaculture and fishery is facing the problems of compensating for lost cultivating plots, allotment of new ones and conflicts of interest between different cultures and fisheries. (Author's abstract)
W89-05239

9. MANPOWER, GRANTS AND FACILITIES

9D. Grants, Contracts, and Research Act Allotments

FISCAL YEAR 1987 PROGRAM REPORT (MAINE LAND AND WATER RESOURCES CENTER),
Maine Univ., Orono. Land and Water Resources Inst.
G. K. White.
Available from National Technical Information Service, Springfield, VA 22161 as PB88-253331/AS, price codes: A03 in paper copy, A01 in microfiche. Program Report G1426-01, July 1988. 29 p, 19 ref, 5 append. Contract 14-08-0001-G1426. Project USGS G1426-01.

Descriptors: *Water Research Institute, *Research, *Information transfer, *Training, *Maine, Education, Projects.

'...Effects of Site Disturbance on the Mobilization of Accumulated Trace Metals...' revealed alterations in soil chemical properties, risk of tree nutrition degradation, and possible episodic violations of federal drinking water standards for groundwater. Preliminary evaluation in 'Terrestrial Vs. In-Stream Sources of Dissolved Al During Episodic Low pH Events' suggests that terrestrial sources are more important than in-stream sources, during precipitation events, at the study sites. 'Reduction of Nitrate Contamination of Groundwater by Septic Tank Effluent' concluded that neither type of filter media studied is appropriate for this application; possibly plastic media could be successful in more densely packed configurations. 'Maine Peatlands...Evaluation for Preservation' should provide a basis for designing a peatland preservation system in the face of growing pressure on the resource; Maine has an exceptional diversity of peatland types. 'Response of Stream Macroinvertabrates to Controlled Sediment Additions' hopes to provide adequate water quality criteria to define detrimental effects on stream biota of sedimentation caused by logging activity in forested Maine watersheds. Seepage lakes (perched on or hydrologically connected with sand/gravel aquifers) are

potentially very sensitive to atmospheric pollution, and one project is making a 'Preliminary Assessment of the Chemical Status of Small Maine Lakes Hydrologically Connected with Aquifers.' Preliminary data from 'The Effectiveness of Buffer Strips to Protect Water Quality' indicate that natural buffers, widely used to protect Maine waters from nonpoint pollution, do appear effective in reducing P and suspended solids from residual runoff. 'Information Transfer in Water Resources' was carried out through publications, conferences, and slide programs covering such topics as drinking water, flooding, public access to water, land use planning, and geographic information systems. (USGS)
W89-05783

FISCAL YEAR 1987 PROGRAM REPORT (GUAM WATER AND ENERGY RESEARCH INSTITUTE).
Guam Univ., Agana. Water and Energy Research Inst. of the Western Pacific.
Available from National Technical Information Service, Springfield, VA 22161 as PB89-102214/AS, price codes: A03 in paper copy, A01 in microfiche. Program Report G-1417-01, July 1988. 22 p. Contract 14-08-0001-G1417. Project USGS G1417-01.

Descriptors: *Water Research Institute, *Research, *Information transfer, *Training, *Guam, Education, Projects.

An overview of the Fiscal year 1987 research and information transferactivities accomplished by the University of Guam Water and Energy Research Institute is given. The activities were sponsored by the Water Research Institute Program of the U.S. Geological Survey and include the following completed projects: 1. Modeling Guam's water supply for development of optimal management strategies. 2. Significance of runoff and terrestrial erosion to the nutrient status of the estuaries of Guam. 3. Modification of a two dimensional saltwater intrusion model for use on a personal computer and calibration of the model for the northern Guam lens. 4. Atoll groundwater development modeling - Laura Phase II. 5. An analysis of water rights issues in Saipan Commonwealth of the Northern Marianas, The Territory of Guam and the Republic of Belau. (USGS)
W89-05786

FISCAL YEAR 1986 PROGRAM REPORT (SOUTH DAKOTA WATER RESOURCES INSTITUTE),
South Dakota State Univ., Brookings. Water Resources Inst.
A. R. Bender.
Available from National Technical Information Service, Springfield, VA 22161 as PB88-201710/AS, price codes: A04 in paper copy, A01 in microfiche. Report G 1252-01, 1987. 50 p. Contract 14-08-0001-G1252. Project USGS G1252-01.

Descriptors: *Water Research Institute, *South Dakota, *Research, *Information transfer, *Training, Research projects, Education.

Development of agricultural water use and the maintenance of adequate and safe water supplies for industrial and domestic use are high priority issues in South Dakota. The FY86 SWRIP supported five projects involving the concept of total water management and groundwater protection. Total water management considers the complex interactions of vegetative growth, agricultural management, soil chemical and physical properties, storage and movement of soil water, and the effects of those interactions on surface and groundwater quality. Other projects investigated the impact of gravel mining excavations on the quality of a municipal water supply and concluded that significant decreases in treatment costs would result if the resource were used. The information dissemination program provided usable information to researchers, resource managers, agencies, and the public. The program was developed cooperatively by higher education faculty and state and federal agencies. (USGS)
W89-05788

10. SCIENTIFIC AND TECHNICAL INFORMATION

10C. Secondary Publication And Distribution

WASTE MINIMIZATION: HAZARDOUS AND NON-HAZARDOUS SOLID WASTE (1980 TO PRESENT).
Environmental Protection Agency, Washington, DC. Information Resources and Services Branch.
For primary bibliographic entry see Field 5E.
W89-04880

BIBLIOGRAPHY OF U.S. GEOLOGICAL SURVEY WATER-RESOURCES REPORTS FOR UTAH,
Geological Survey, Salt Lake City, UT. Water Resources Div.
S. L. Dragos, and L. S. Conroy.
Utah Department of Natural Resources Information Bulletin No. 28, 1987. 89p, 4 tab.

Descriptors: *Bibliographies, *Water resources, *Utah, Hydrology, Geology, Geohydrology, Water quality.

A bibliography was compiled that contains a complete listing to December 31, 1986, of reports relating to the water resources of Utah prepared by personnel of the U.S. Geological Survey. Discussions of the related subjects of geology, hydrology, and chemical quality of the water are included in many of the reports. The reports were, for the most part, prepared by personnel assigned to the Water Resources Division, Utah District, in cooperation with State, and other Federal, and local agencies. The bibliography is divided into four major parts: (1) publications of the Geological Survey; (2) publications by agencies of the State of Utah; (3) other publications - reports prepared by Survey personnel, but published by other agencies or by professional organizations in their journals; and (4) reports of the Geological Survey. (Lantz-PTT)
W89-05404

10D. Specialized Information Center Services

CRITERIA FOR EVALUATING THE RELIABILITY OF LITERATURE DATA ON ENVIRONMENTAL PROCESS CONSTANTS,
Environmental Research Lab., Athens, GA.
H. P. Kollig.
Toxicological and Environmental Chemistry TXECBP, Vol. 17, No. 4, p 287-311, 1988. 10 ref.

Descriptors: *Literature review, *Publication review, *Documentation, *Public health, *Hazardous materials, Data interpretation.

In the assessment of health risk from pollutant exposure, it is important for the modeler to know the degree of confidence he can have in literature values that are needed for estimating the fate of toxic substances in the environment. Since literature values in general are of unknown reliability, evaluation criteria were developed for 12 rate and equilibrium constants used in environmental modeling. A Data Reliability Indicator (DRI) may be developed as a measure of the degree of confidence with which a literature value can be used. The DRI is based on criteria which are divided into four major categories: (1) chemical analysis information; (2) experimental information; (3) statistical information; and (4) corroborative information. By evaluating the documentation describing the value's experimental procedure, a modeler would be able to estimate the degree of confidence with which to regard a particular literature value. The evaluation criteria also can be used to assess the reliability of literature values for other properties. (Sand-PTT)
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REUSE AND DISPOSAL OF HIGHER SALINITY SUBSURFACE DRAINAGE WATER: A REVIEW,
California Regional Water Quality Control Board, Sacramento.
For primary bibliographic entry see Field 3C.
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Toronto Univ. (Ontario). Inst. for Environmental Studies.
For primary bibliographic entry see Field 5A.
W89-05330

OVERVIEW OF GROUNDWATER MODELLING,
Princeton Univ., NJ. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2F.
W89-05472

STATE OF THE ART OF THE INVERSE PROBLEM APPLIED TO THE FLOW AND SOLUTE TRANSPORT EQUATIONS,
Universidad Politecnica de Cataluna, Barcelona (Spain). Escuela Tecnica Superior de Ingenieros de Caminos, Canales y Puertos.
For primary bibliographic entry see Field 2F.
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PRESENT STATE OF COASTAL AQUIFER MODELLING: SHORT REVIEW,
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BIBLIOGRAPHIES
Waste Minimization: Hazardous and Non-Hazardous Solid Waste (1980 to Present).
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U.S. Environmental Protection Agency Emergency Response to Toxic Fumes and Contaminated Ground Water in Karst Topography: Bowling Green, Kentucky,
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Developing a State Water Plan: Ground-Water Conditions in Utah, Spring of 1983,
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Bibliography of U.S. Geological Survey Water-Resources Reports for Utah,
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Chemical Effects of Highway Runoff on the Surficial Aquifer, Broward County, Florida,
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Reconnaissance of Geohydrologic Areas and in 1981 Low-Flow Conditions, Withlacoochee River Basin, Southwest Florida Water Management District,
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Changes in Hydrologic Conditions Related to Large Floods on the Escalante River, South-Central Utah,
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Multivariate Techniques for the Identification of Homogeneous Flood Frequency Regions,
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Potentiometric Surface of the Upper Floridan Aquifer in Georgia, May 1985, and Water-Level Trends, 1980-85,
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Modeling Transient Ground Water Flow in Multilayered Aquifer Systems,
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Effect of Soil Dispersion on Surface Run-Off in Southern Piedmont Soils,
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Fundamentals and Analytical Applications of Bioluminescence,
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Computational Methods in Subsurface Flow,
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Effect of Water Conservation on the Yield of Upland Crops in the Humid Tropics,
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Low Slump Compaction Grouting for Correction of Central Florida Sinkholes,
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Apparatus for the Investigation of Microbial Reaction Rates in Sediment Suspensions,
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Annual Report, Analysis of Acid Precipitation Samples Collected by State Agencies,
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Validity of an Ecotoxicological Test System: Short-term and Long-term Effects of Arsenate on Marine Periphyton Communities in Laboratory Systems,
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Induced Community Tolerance in Marine Periphyton Established under Arsenate Stress,
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GOLDER ASSOCIATES, MISSISSAUGA (ONTARIO).
Specialized Investigation Techniques for Defining Karstic Cavities,
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Diazinon Toxicity Effect on Protein and Nucleic Acid Metabolism in the Liver of Zebrafish, Brachydanio Rerio (Cyprinidae),
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Drainage Effect on the Environment,
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Up-To-Date Method to Study Marsh-Ridden Areas in West Siberia,
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Water and Energy Regime of Palsa Bogs in West Siberia,
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GREAT LAKES FORESTRY RESEARCH CENTRE, SAULT SAINTE MARIE (ONTARIO).
Water Table Profiles of Drained Forested and Clearcut Peatlands in Northern Ontario, Canada,
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Water and Chemical Budgets for Terrestrial Basins at the Turkey Lakes Watershed,
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Acid Deposition and Nutrient Leaching from Deciduous Vegetation and Podzolic Soils at the Turkey Lakes Watershed,
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Fish Community Structure, Biomass, and Production in the Turkey Lakes Watershed, Ontario,
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Young-of-the-Year Fish Community in Nine Lakes, Varying in pH, on the Canadian Shield,
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GRONINGEN RIJKSUNIVERSITEIT (NETHERLANDS). DEPT. OF PHYSICAL GEOGRAPHY.
Modelling Forest Water Consumption in the Netherlands,
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GUAM UNIV., AGANA. WATER AND ENERGY RESEARCH INST. OF THE WESTERN PACIFIC.
Fiscal Year 1987 Program Report (Guam Water and Energy Research Institute).
W89-05786 9D

GUELPH UNIV. (ONTARIO). DEPT. OF ENVIRONMENTAL BIOLOGY.
Effect of Acid Precipitation on Microbial Decomposition Processes in Sediment from Streams in the Turkey Lakes Watershed,
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GUELPH UNIV. (ONTARIO). DEPT. OF ZOOLOGY.
Total Cadmium Concentrations in the Water and Littoral Sediments of Central Ontario Lakes,
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Multivariate Analysis of Correlations between Environmental Parameters and Cadmium Concentrations in Hyalella Azteca (Crustacea: Amphipoda) from Central Ontario Lakes,
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Accumulation and Excretion of Five Heavy Metals by the Saltmarsh Cordgrass Spartina alterniflora,
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Hampton Roads Sanitation District's Compost Marketing Program,
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About the Numerical Analysis of Dynamics in Multi-Component-Continua,
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Degradation of N-methylcarbamate and Carbamoyl Oxime Pesticides in Chlorinated Water,
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HEALTH EFFECTS RESEARCH LAB., CINCINNATI, OH.
Effect of Environmental Variables on Enteric Virus Survival in Surface Freshwaters,
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Towards a Long-Term Balance Between Economics and Environmental Protection,
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Ditch Cleaning and Additional Ditching in Peatland Forestry: Effect on Ground Water Level,
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Dehydroabietic Acid (DHAA) Does Not Inhibit Bilirubin Conjugation in the Liver of Rainbow Trout,
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Snow Melt and Runoff in Aapa-Mire in Finnish Lappland,
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Influence of Evapotranspiration on the Groundwater Table in Peatland,
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Methods for the Treatment of Contaminated Dredged Sediments,
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City of Tampa Sludge Pelletizing Project,
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Removal of Chromium from Ion Exchange Regenerant Solution,
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HUMBOLDT STATE UNIV., ARCATA, CA. DEPT. OF ENVIRONMENTAL RESOURCES ENGINEERING.
Groundwater Systems Planning and Management,
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Trace Element Content in Drinking Water of Nasopharyngeal Carcinoma Patients,
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Deep Water Discharge: Key to Hydrocarbon and Mineral Deposits,
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Changes in the Structural and Functional Components of the Fish Community of a Seasonal River,
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Soil Pollution by Metals from Mining and Smelting Activities,
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Selenate Reduction by Bacteria from a Selenium-Rich Environment,
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Application of a Numerical Ground-Water Flow Model to the Mud Lake Area in Southeastern Idaho,
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Geology for Planning in Boone and Winnebago Counties,
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Electric Earth Resistivity Survey of the Macon-Taylorville Ridged-Drift Aquifer,
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Geology for Planning in Boone and Winnebago Counties.
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Development of a Versatile Flood Frequency Methodology and Its Application to Flood Series from Different Countries,
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Trace Metal Contamination From Brass Fittings,
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Local Groundwater Protection,
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Total Exposure and Risk Assessment for Drinking Water Contaminated with Volatile Organic Compounds,
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Anaerobic Fluid-Bed Treatment of Coal Conversion Wastewater,
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Anaerobic Biodegradation of Phenol: Inhibition Kinetics and System Stability,
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Use of a Chemical Equilibrium Model to Understand Soil Chemical Processes That Influence Soil Solution and Surface Water Alkalinity,
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Environmental Policy in Britain: Reaffirmation or Reform,
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Field Validation of an Empirical Soil Water Model,
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Biological Treatment of Pharmaceutical Wastewater,
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INDIANA DEPT. OF ENVIRONMENTAL MANAGEMENT, INDIANAPOLIS. OFFICE OF WATER MANAGEMENT.
1985 Water Quality Monitoring Rivers and Streams.
W89-04625 5B

INDIANA DEPT. OF ENVIRONMENTAL MANAGEMENT, INDIANAPOLIS. WATER QUALITY SURVEILLANCE AND STANDARDS BRANCH.
Summer Primary Productivity and Associated Data for Four Indiana Rivers,
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Role of Advection in the Energy Balance of Late-lying Snowfields: Niwot Ridge, Front Range, Colorado,
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Biological Assemblages of Miller Woods Ponds, Indiana Dunes National Lakeshore, Gary, Indiana,
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Environmental Management of New Mining Operations in Developed Countries: The Regional Copper-Nickel Study,
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Stream-variable Response to a Change in Surficial Geology: Middle Fork, Big Walnut Creek, Hendricks County, Indiana,
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Confirmation of a Mammalian Poison Classification Using a Water Flea (Daphnia magna) Screening Method,
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Winning with Water: Soil-Moisture Monitoring for Efficient Irrigation,
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INLAND WATERS DIRECTORATE, VANCOUVER (BRITISH COLUMBIA). MONITORING AND AGREEMENTS DIV.
Goals and Data Collection Designs for Water Quality Monitoring,
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Displacement of Chernobyl Fallout in Snow Layers of Temperate Alpine Glaciers,
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Coliphages and Enteric Viruses in the Particulate Phase of River Water,
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Effect of Watertable on Yield and Root Depth of Winter Wheat in the French West Central Atlantic Marshlands,
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Amino Acid Uptake by a Natural Population of Oscillatoria rubescens in Relation to Uptake by Bacterioplankton,
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INSTITUT NATIONAL DE LA SANTE ET DE LA RECHERCHE MEDICALE, PARIS (FRANCE).
Uptake of Zn and Cd by Coastal Phytoplankton Species in Culture,
W89-04769 5B

INSTITUT PASTEUR DE LYON (FRANCE).
Acute Toxicity of Cresols, Xylenols, and Trimethylphenols to Daphnia magna Straus 1820,
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INSTITUT ZA VODOPRIVREDU JAROSLAV CERNI, BELGRADE (YUGOSLAVIA).
Effects of Subsurface Drainage on Heavy Hydromorphic Soil in the Nelindvor Area, Yugoslavia,
W89-05108 4C

INSTITUTE FOR LAND AND WATER MANAGEMENT RESEARCH, WAGENINGEN (NETHERLANDS).
Effects of Drainage on Crops and Farm Management,
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Effect of Swelling and Shrinkage on the Calculation of Water Balance and Water Transport in Clay Soils,
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Description of a Regional Groundwater Flow Model SIMGRO and Some Applications,
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Importance of Hydrological Research in Designing Rural Water Management Systems as Part of Land Development Projects in the Netherlands,
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Operational Aspects of Surface Water Management in Relation to the Hydrology of Agricultural Areas and Nature Reserves,
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Hydrological Research and the Design of a Water Management System for a Peatland Area with Agriculture and Nature in the Land Consolidation Project: Echtener and Groote Veenpolder,
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Hydrochemistry of Rich Fen and Water Management,
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Multiobjective Approach to Water Management System for Wetlands in Biebrza River Valley: Case Study,
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Behaviour and Impact Assessment of Heavy Metals in Estuarine and Coastal Zones,
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Reduction of Selenate by Fulvic Acids in Soils of a High Gastric Cancer Risk Area in Sri Lanka,
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rhoCO2 Variations in Streamwaters Draining an Acidic and Acid Sensitive Spruce Forested Catchment in Mid-Wales,
W89-05020 5B

Combined Regional Flood Frequency Analysis and Regression on Catchment Characteristics by Maximum Likelihood Estimation,
W89-05624 2E

Testing the Suitability of the Two-Component Extreme Value Distribution for Regional Flood Estimation,
W89-05627 2E

INSTITUTE OF HYDROLOGY, WALLINGFORD (ENGLAND). OVERSEAS CONSULTANCY GROUP.
Comparison of Flood Frequency Curves for Many Different Regions of the World,
W89-05632 2E

INSTITUTE OF TERRESTRIAL ECOLOGY, BANGOR (WALES). BANGOR RESEARCH STATION.
Impact of Afforestation on the Soil Solution Chemistry of Stagnopodzols in Mid-Wales,
W89-04985 2G

INSTITUTO ARGENTINO DE OCEANOGRAFIA, BUENOS AIRES.
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Distribution of Three Nymphaeid Macrophytes (Nymphaea alba L., Nuphar lutea (L.) Sm. and Nymphoides peltata (Gmel.) O. Kuntze) in Relation to Alkalinity and Uptake of Inorganic Carbon,
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Differential Uptake of Orthophosphate and Organic Phosphorus Substrates by Bacteria and Algae in Lake Kinneret,
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Environmental Assessment of Peatland Development Operations in Newfoundland,
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Readjusting the Water Balance to Combat Dryland Salting in Southern Australia: Changing the Hydrology of a Texture Contrast Soil by Deep Ripping,
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Fiscal Year 1987 Program Report (Maine Land and Water Resources Center),
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MINISTRY OF AGRICULTURE, FISHERIES AND FOOD, CAMBRIDGE (ENGLAND). FIELD DRAINAGE EXPERIMENTAL UNIT.
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UNIVERSIDAD POLITECNICA DE MADRID (SPAIN). ESCUELA TECNICA SUPERIOR DE INGENIEROS DE CAMINOS.
Estimation of Spatial Covariance Structures with Application to Hydrological, Hydrochemical and Isotopic Data from Aquifers: State-of-the-Art and Adjoint State Maximum Likelihood Cross-Validation Methods,
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UNIVERSIDAD POLITECNICA DE VALENCIA (SPAIN).
Eigenvalues Approach for Solving Linear Groundwater Flow Problems,
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UNIVERSIDADE FEDERAL DO MARANHAO, SAO LUIS (BRAZIL). LAB. DE HIDROBIOLOGIA.
Preliminary Survey of Heavy Metal Concentrations in some Estuarine Organisms in the Littoral Zone of Sao Luis Island, Maranhao, Brazil,
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UTRECHT RIJKSUNIVERSITEIT (NETHERLANDS). DEPT. OF PLANT ECOLOGY.
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Subject Fields

1 NATURE OF WATER

2 WATER CYCLE

3 WATER SUPPLY AUGMENTATION AND CONSERVATION

4 WATER QUANTITY MANAGEMENT AND CONTROL

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1989 Price Schedules for the United States, Canada, and Mexico

These prices are for customers in the United States, Canada, and Mexico; other customers, write for price list PR-360-4.

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A06-A09	21.95	E05	17.50	D05	225	T05	525
A10-A13	28.95	E06	20.50	D06	275	T06	625
A14-A17	36.95	E07	23.00	D07	325	T07	725
A18-A21	42.95	E08	25.50	D08	375	T08	825
A22-A25	49.95	E09	28.00	D09	425	T09	925
A99	*	E10	31.00	D10	475	T10	1,025
		E11	33.50	D11	525	T11	1,125
		E12	36.50	D12	575	T12	1,225
		E13	39.00	D13	625	T13	1,325
		E14	42.50	D14	675	T14	1,425
Published Searches & Special Directories		E15	46.00	D15	725	T15	1,525
		E16	50.50	D16	775	T16	1,625
		E17	54.50	D17	825	T17	1,725
		E18	59.00	D18	875	T18	1,825
		E19	65.50	D19	925	T19	1,925
N01	$55.00	E20	76.00	D99	*	T99	*
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